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THE
JOURNAL OF APPLIED PSYCHOLOGY

VOL. VI DECEMBER, 1922 No. 4

MEASURES OF GENERAL INTELLIGENCE AS INDICES OF SUCCESS IN TRADE LEARNING.[1]

By Karl M. Cowdery
Whittier State School

Psychological tests are being widely investigated as a means of identifying persons who have the abilities to make successful records in industrial and mechanical occupations. For this purpose several types of tests have been suggested, among which are analytical tests such as the series used by Dr. Helen T. Wooley (18)[2], which seek to measure specific abilities; the "sample" tests of the performance trade test type such as are described by J. Crosby Chapman (4), wherein the subject performs operations which actually appear in the field of activity for which the person is applying; the analagous tests, described by H. E. Burtt (3), in which the person tested is made to perform operations which are considered as containing the elements involved in the occupation; and the miniature which simulates on a small scale the exact conditions of the commercial task. In his book entitled "Employment Psychology," H. C. Link (10) describes the methods and applications of psychology to employment in both general and specific industries, and outlines the extent to which psychological methods are and may be used. He implies in his chapter on General Intelligence that he finds little or no relation between general intelligence and industrial abilities but states that specific abilities are of more value as indices of the potential capacity of a prospective employee. He is dealing, however, with operations rather than with occupations or trades.

Other writers who have considered the problem of ability for trade learning, in its broadest sense, have not agreed among themselves as to the relations which exist between measures of general

[1] A study made under the direction of Dr. Lewis M. Terman, Stanford University, and Dr. J. Harold Williams, Director, California Bureau of Juvenile Research, Whittier State School, Whittier, California.

[2] Numbers in parenthesis indicate references cited at the end of this study.

intelligence and success in occupations. The lists of occupations open to the feeble-minded given by Miss M. L. Anderson (1) and by Miss Ada Fitts (5), and the industrial capacities outlined by Dr. H. H. Goddard (7), indicate that persons even of low intellectual standing are not entirely barred from useful vocational activity, particularly if given suitable supervision. Dr. George Ordahl (11) gives figures which, within a certain small range and at a low level of mental rating, suggest that morons can engage in productive labor along with those of higher abilities provided their work is properly planned and supervised. He also suggests that for this work (tomato canning) the persons of higher levels of intelligence are proportionately more productive. C. S. Rossy (12) states that his study of institutional work suggests farm work most suited to the feeble-minded. Miss Anderson (1) points out that the work which is available for the low grade individuals is not trade work and that defectives cannot take part in the more skilled trades demanding shop training. The question then arises, What is the lowest limit of mental rating that will permit of trade training?

Assuming that the lowest limit of intelligence permitting successful trade learning has not been found, what is the relation of success in learning to the extent to which the learner's rating exceeds the minimum level? Bridges and Coler (2) find that the children of the skilled class of workmen have average intelligence levels distinctly higher than those of the unskilled laborers. Greater progress, in these cases, has been made by the parents of children whom tests have shown to possess superior intelligence. If the relative levels of intelligence among the children fairly represent the status of the parents the conclusion is to be drawn that greater general mental ability foretells more advanced occupational learning. Dr. L. M. Terman (13) and Dr. Helen T. Wooley (17) find similar differences between different classes of workmen. These studies relate to associated problems but do not measure directly the relation of general intelligence to learning the same tasks or to success in the same activities.

J. K. Flanders (6) found a low correlation between I. Q. and the salaries paid to express company employees and concluded that there are other factors of more importance than intelligence which determine the value of a man to his employer. M. S. Viteles (16) expresses the opinion that "trade competency is related to specific abilities which the individual possesses," and that "general intelligence tests can not be used for the selections for a great mass of skilled and semi-skilled jobs, such as office and clerical jobs." On the other hand Dr. L. L. Thurstone (14) says "I do not believe that

office work has any special abilities," and as a test combines several psychological measures, finding a combination whose scores correlate more highly with the rated abilities of the subjects than do any of the individual tests for specific abilities. R. W. Kelly (9) believes that intelligence tests are most useful in connection with upper levels of work such as clerical workers, executives and salesmen. Link (10) found a correlation of .55 between general intelligence and technique in office work. For ability in specific tasks such as the gauging and inspection of shells he found but low correlations between mental rating and ability to do that work. The U. S. Army (15) used mental rating as one of the important criteria in selecting officer training material, and also found, according to Henmon (8), direct relations between native intelligence and flying ability in the aviation training fields.

Consideration of the material in the literature cited suggests two problems in connection with the task of selecting trade training for boys, (a) the minimum necessary level of intelligence for successful learning of the activities and coordinations involved in the various trades, and (b) the relative value of different levels of intelligence above the minimum.

At the Whittier State School, Whittier, California, boys between the ages of 12 and 19 have been assigned to the learning and performing of "trade" work under conditions which may be termed apprenticeship. That is, they are working with the materials and in the operations of trades directly under the guidance and supervision of experienced journeymen or expert workmen in the respective trades. The assignments to the different trades have been such that a considerable range of mental age level is represented in every group of boys in the various "details."

This study was undertaken to determine with more exactness than is afforded by routine observation to what extent the measure of the general intelligence of the boys can or should be used in deciding the specific assignment of a boy to one trade rather than to another. The objectives or criteria sought in the study are those suggested above, namely, the minimum level of intelligence necessary for success, and the relation of success to varying degrees of mental ability for the different trade groups.

For such a study there were available to the writer the information contained in the files of the Whittier State School and those at the California Bureau of Juvenile Research[3] which gave the results of individual tests of each boy by means of the Stanford Re-

[3]The writer is indebted to Superintendent Fred C. Nelles of the Whittier School and to Dr. J. Harold Williams, Director of the Bureau of Juvenile Research at the Whittier State School, for their co-operation in making available the material for the study on which this article is based.

vision of the Binet-Simon Intelligence tests. The data used include the I. Q., the age of the boy at the time of assignment to trade work, and the mental age at that time.

As a measure of the success of the individual boys in their respective trade work only a descriptive report of the boys' work was available at the time of starting the study (1919). A new form of report was then prepared for use thereafter whereby at the beginning of each month the instructor made a rating of the work done by each boy during the preceding month. Three years of accumulation of these records have given a set of ratings on each of 578 assignments to 22 different trade groups.

The ratings of the instructors were on a five division scale whereby the work of the boy was scored as *excellent, good, fair, poor* or *bad.* To obtain a single index of the work done by the boy during his entire period in the trade an arithmetical average of all ratings for each boy was made, known in this study as the Trade Average.

To find the relations which actually existed between the success of the individuals and their mental ratings, distributions for each group were made of the Trade Averages by Mental Age Levels. From these distributions the coefficients of correlation were computed and graphic representations were made to determine the critical levels of minimum ability required for success. As suggested by H. O. Rugg (Statistical Methods

TABLE I

DISTRIBUTION OF INTELLIGENCE QUOTIENTS

I. Q. s		f		%
1.25-1.29		2		0.3
1.20-1.24		..		....
1.15-1.19		5		0.8
1.10-1.14		3		0.5
1.05-1.09		22		3.8
1.00-1.04		26		4.5
.95- .99		49		8.5
.90- .94		61		10.6
.85- .89		82		14.2
.80- .84	*	80	*	13.9
.75- .79		83		14.4
.70- .74		65		11.2
.65- .69		53		9.2
.60- .64		21		3.6
.55- .59		16		2.8
.50- .54		6		1.0
.45- .49		4		0.7
Totals		578		100.0

* Indicates level of median case.

Applied to Education, p. 291) correlations were made by the Spearman Footrule Formula, or method of grades, where the number of cases is less than 30. For frequencies of more than 30 the Pearson Products Moment Formula was used. The critical levels were so located that 75 per cent. or more cases below that level fail to receive a rating of median or above, or that 75 per cent. or more of the cases above that level are rated as median or better. The former represents the "lower critical level" or minimum level necessary for success. The latter is an indication of a level above which there is greatest expectation of success.

Correlations of success with I. Q. and with Chronological age are computed for comparison. Table I gives the distribution of the

TABLE II

DISTRIBUTION OF CHRONOLOGICAL AND MENTAL AGES,

Levels	f	C.A. %	f	M.A.%
19:6-19:11	3	0.5		
19:0-19:5	2	0.3		
18:6-18:11	1	0.1		
18:0-18:5	3	0.5		
17:6-17:11	8	1.4	2	0.3
17:0-17:5	17	3.0	3	0.5
16:6-16:11	39	6.8	5	0.8
16:0-16:5	72	12.5	5	0.8
15:6-15:11	91	15.8	13	2.3
15:0-15:5	95 *	16.5	17	3.0
14:6-14:11	88	15.3	31	5.4
14:0-14:5	68	11.8	39	6.8
13:6-13:11	52	9.0	48	8.3
13:0-13:5	21	3.6	53	9.2
12:6-12:11	9	1.4	49	8.5
12:0-12:5	4	0.7	67	11.7
11:6-11:11	3	0.5	46 *	8.0
11:0-11:5	2	0.3	40	6.9
10:6-10:11			53	9.2
10:0-10:5			37	6.4
9:6- 9:11			24	4.2
9:0- 9:5			14	2.4
8:6- 8.11			18	3.1
8:0- 8:5			7	1.2
7:6- 7:11			5	0.8
7:0- 7:5			1	0.1
6:6- 6:11			1	0.1
Totals	578	100.0	578	100.0

* Indicates level of median.

Intelligence Quotients for the 578 cases. Table II is a tabulation of the chronological and mental ages of the boys at the time each entered the trade group. The medians of the actual and mental

ages are noted as being 15:3 and 11:9 respectively. For the group there is an average retardation of 3 years and 6 months, the median I. Q. being .82.

Table III gives the frequencies for each trade group together with the coefficients of correlation between the Trade Averages and the Intelligence Quotients, chronological ages and mental ages.

TABLE III

CORRELATIONS WITH TRADE AVERAGES.

Trade Groups	f	I. Q.	C. A.	M. A.
I. Printing Trades				
Print Shop	51	.116±.092	.314±.086	.334±.034
Bookbindery	18	-.200±.145	-.005±.15	-.305±.14
II. Mechanical				
Carpenter	32	.255±.112	-.088±.119	.306±.109
Paint	20	.283±.138	-.366±.13	.283±.138
Plumbing	11	-.259±.14	-.045±.15	-.377±.13
Blacksmith	21	.211±.141	.244±.138	.299±.134
Garage	11	.259±.16	.259±.16	.259±.16
III. Garment				
Tailor	78	-.212±.073	.227±.072	.232±.072
Shoe	34	-.342±.102	-.003±.117	-.313±.103
Laundry	33	-.308±.106	.015±.117	-.297±.107
IV. Culinary				
Kitchen	32	-.343±.105	.600±.067	.093±.120
Bakery	26	-.275±.122	.476±.102	-.016±.132
V. Farming				
Dairy	32	-.147±.117	.091±.119	-.126±.118
Poultry	22	.337±.127	.393±.122	.600±.092
Teamsters	24	-.013±.138	-.105±.136	-.087±.137
Vegetable G.	20	-.184±.146	.307±.137	-.234±.143
VI. Miscellaneous				
Office Boys	7			.983±.009
Flower Garden	18	-.169±.146	-.169±.146	-.071±.150
Power House	8	.000	.000	.247±.224
Hospital	7		.414±.211	.414±.211
VII. Service				
Housekeepers	38	-.094±.108	-.146±.107	-.147±.107
Dining Room	35	.055±.114	.001±.114	.030±.114

Charts I, II, and III are sample diagrams representing the three types of relationship found between Trade Averages and mental levels. Each of these diagrams is discussed in connection with the trade group which it represents.

PRINTING TRADES

1. **Print Shop.** The work of the print shop includes the production of record forms, stationary, and other similar material for the use of the School offices; a bi-weekly School paper of local news and interests; a bi-monthly scientific journal, the Journal of Delinquency; and various bulletins, monographs and other less ex-

tensive pamphlets both for the school and for the Bureau of Research.

Training and experience are provided in the theory and practice of type-setting (hand method), paging, make-up, press-feeding, and the various processes involved in job printing. The average size of the class is 14 boys.

The instructor has had commercial experience in printing as a "trade" without the limited specialization common to the activities of the occupation. In addition to his commercial work he has taken teacher-training class instruction toward certification as a vocational teacher.

The distribution of ratings, given in Chart I, has made use of the full rating scale and has closely approximated the normal distribution curve.

Correlation represented by a coefficient .334±.084 between mental age levels and Trade Averages is found. This is interpreted as meaning that there is a definite, tho not large, tendency for probability of success to be relatively greater as the standing of the individuals receiving instruction approaches and exceeds the median intelligence of the group. The diagram of the distribution shows that on the basis of 75 per cent or more success an upper critical level is justified at the mental age of 15:0. In other words, of the 12 cases rated as having mental ages above 15 years, 9 receive median or better Trade Averages. Similarly at the other end of the range, 6 of the 7 cases below a mental age of 12:3 fail to reach the median of success. The lower critical level is placed at this location.

The conclusion is drawn that a minimum mental age level of 12 years 3 months is requisite for reasonable progress in learning the printing trade; that more and more success is expected as higher mental levels are represented, and that of those cases above the level 15:0 at least 75 per cent are expected to be successes.

The coefficient of correlation, .314±.086, between the Trade Averages and chronological age levels, suggests that the factor of actual age should also be considered in making selections of boys for this trade.

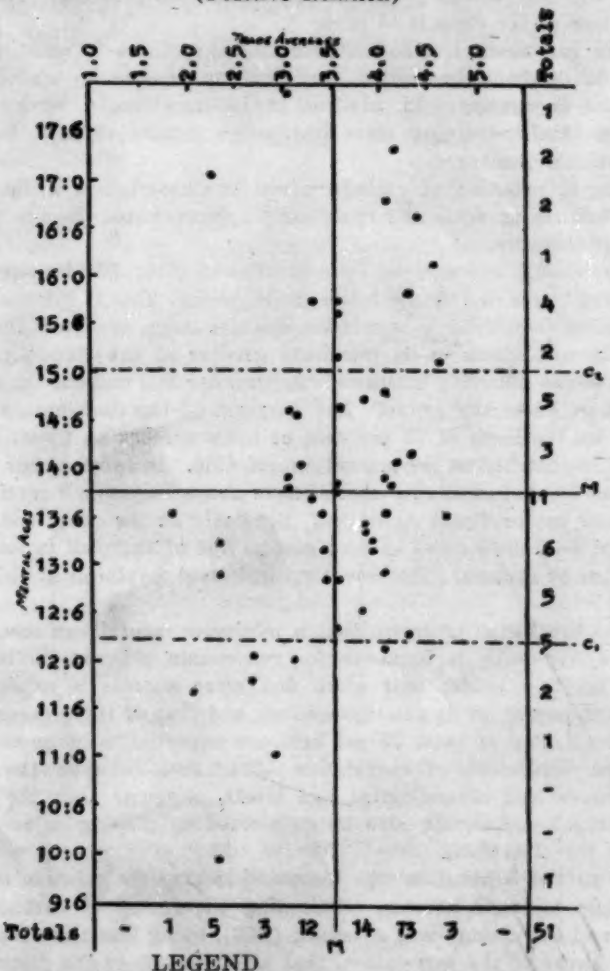
A partial correlation was computed to find the relation of mental age to trade success, eliminating the factor of chronological age and the change was so slight (-.06), being less than the Probable Error of the correlation, that this element of the distribution of actual ages at the various mental ages was considered as negligible.

2. Book-bindery. In the associated trade of book-binding the products of the print shop are folded, trimmed, bound or padded as

CHART I

PRINT SHOP

Distribution of Trade Averages by Mental Age Levels
(Positive Relation)



LEGEND

M Median
C_2 Upper Critical Level
C_1 Lower Critical Level

may be required. Old books are rebound, and small leather articles such as purses and notebook covers are manufactured. There is a comparatively small range of activities involved, and the group of boys is small, four being the average size of the group. This allows for close personal supervision of the work. The combination provides for repeated processes under supervision closely resembling factory conditions.

The relation between mental level and Trade Averages is found to be negative, coefficient of correlation —.305±.14. The boys of lower mental ages adapt themselves best to the type of work involved and the learning of the process requires no more than limited intelligence. The meaning of the lower critical level in this distribution is reversed from that in the print shop group. Seven of the 8 boys having mental ages below 12 years receive averages of median rank or better.

The relation of actual age to success is practically neutral, hence the suggestion is that boys of inferior intelligence are suitable for this kind of work within the limits of the actual ages represented, 11:2 to 15:8.

The range of mental ages for this group did not go below 10 years. It is quite likely that at some level lower than this a critical level would be found which would represent the minimum intelligence level required. We are safe in saying that it is less than 10 years of mental age.

MECHANICAL TRADES

1. Carpenter Shop. The Carpenter Shop gives supervised experience in work which includes the manufacture of furniture and other articles demanding training in "cabinet-making," as well as experience in rougher types of carpentry, and the operation of mill machinery. The shop takes care of all repair work for the school, both of furniture and buildings.

The instruction is in charge of a tradesman with experience in both cabinet-making and mill work, who also holds a special certificate for vocational instruction.

The relation between mental age levels and trade ability is expressed by the co-efficient .306±.109. The association is positive, indicating that intelligence is a factor but not the sole factor which determines degree of success in learning the activities of the trade.

In spite of the positive relation indicated by the coefficient the range of mental ages failed to reveal any critical levels. Within the range 10:0 to 15:0, there is a slight tendency for more success at the upper end of the range than at the lower. Also it is quite no-

ticeable that of those with mental ages below 12:0, the deviations from median success of the failures are greater than those of the successes. In other words, with about even numerical proportions of successes and failures, the degree of the success of those below the median mental age is comparatively limited.

Although boys of mental ages as low as 10 years can learn, those individuals whose intelligence rates above 12:3 attain to greater degrees of success.

2. Paint Shop. The work of the painting detail consists of the finishing of furniture, including flat painting, staining, varnishing, and rubbed finishing; interior painting and decorating, and floor surfacing; outside painting; auto body work; curtain-hanging and glazing. The boys are given instruction in this work, as well as in the preparation of materials, color mixing, care of brushes and tools, and some training in sign construction and lettering.

The instructor is a painter of considerable trade experience and holds a special certificate for vocational instruction.

For the group of 20 boys the distribution presents a positive relationship between mental and trade ability, correlation coefficient .283±.138. The tendency is small but definite. The diagram suggested both an upper and a lower critical level at 14:0 and 11:0 respectively. Not a single median rating was attained by any boy whose mental level was below 11 years. Four out of five above the upper level were rated at the median or better.

The negative relationship between chronological age and success suggests that boys can most profitably be started in the learning of this trade before they are 16 years of age.

The minimum mental age of 11 years is required for successful learning of the operations involved and the highest proportion of success will be expected of boys between 14 and 16 years old whose mental levels are 11 years or higher, preferably above 14 years.

3. Plumbing Shop. The plumbing shop duties consist of general repair work on water, gas, and steam service lines, with little new installation work. The instructor is a journeyman plumber in charge of from one to three boys at a time. He has had no special instructional training.

The limited number of boys observed renders unreliable any statistical indices. The eleven cases rated gave a negative coefficient of correlation between mental age levels and Trade Averages, —.377±.13. No general conclusions seem to be warranted altho this would seem to place this group in the class of trade where intelligence is not an important factor in the early learning process.

4. Blacksmith and Machine Shop. This detail handles all of the

metal working for the school, including forge work and a limited amount of machine practice in the use of lathes, shapers, milling machines and drill presses. The instructor is a forge man who has had some additional machine operation.

The coefficient .299±.134 represents a limited positive relation between intelligence and success. A lower critical level is suggested at M. A. 12:6, but the cases below that level are barely inferior to those attaining median success. Without more cases this level is questionable. However the highest degree of success is attained by those whose mental levels are above 13:6.

Similarly a chronological age of 15:9 or higher predicts the most likelihood of efficient learning.

5. **Garage.** The work of the boys in the garage detail consists primarily in the observation of repair work and actual practice in the general maintenance and driving of automobiles and motor trucks. The detail is small and renders questionable the meaning of a positive correlation coefficient of .259±.16.

GARMENT TRADES

1. **Tailor Shop.** The operations performed in the tailor shop come under three heads, (1) the mending and darning of worn and torn garments, (2) the sorting and inspection of laundered clothing and its issuance to the boys of the School, and (3) the making of new underwear, shirts, work trousers, caps and suits. The work is under the supervision of a woman whose experience in the trade has been largely that of institutional tailoring instruction. The detail contains an average of 20 boys.

The ratings of the instructor are contained in a comparatively narrow range of the rating scale and are therefore not as reliable as the distribution represented in the charts.

For the 78 cases included in this detail a slight positive relation is found, .232±.072. But in the wide range of mental ages, 7:6 to 17:8, no critical levels are indicated. Apparently very low intelligences are sufficient for producitve work in this shop, and the lower critical level falls below 7 years 6 months.

2. **Shoe Shop.** Shoes are both made and repaired in the shoe shop. A few other leather articles such as footballs are cut and made from pattern. Each boy passes in succession thru the various processes involved in the making of the shoes, but since the styles of shoe are limited, the number and variety of problems faced are comparatively few. There is considerable repetition of activity.

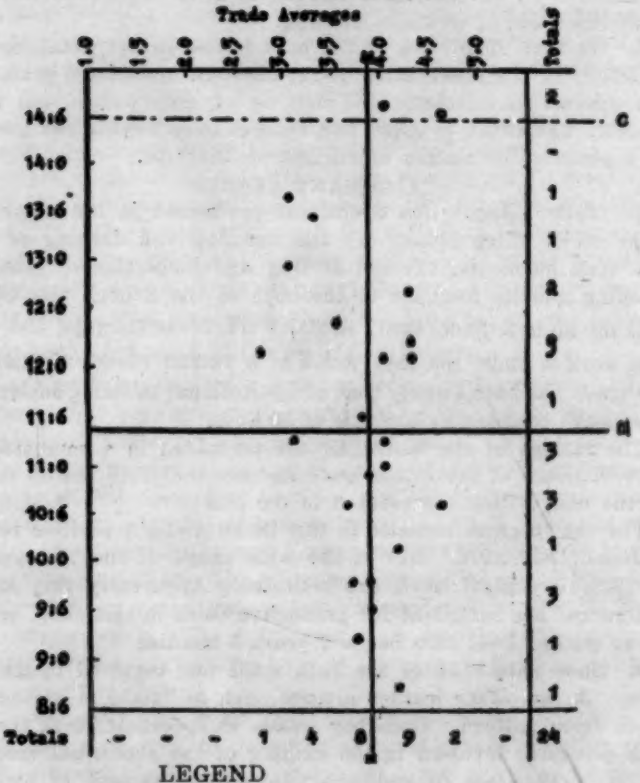
A distinct negative relationship is found between mental rating and Trade Averages, —.313±.103. Only a very low level of intelligence is required for successful learning, the minimum level

falls somewhere below the lower limit of our range, 6:6. On the other hand the higher levels of ability find difficulty in adapting themselves to the operations and restricted supervised activities of the trade learning under the shop conditions. Chart III represents the distribution and shows the reversed critical levels at years 10:0 and 12:3.

CHART II

TEAMSTERS

Distribution of Trade Averages by Mental Age Levels
(Neutral Relation)



3. **Laundry.** The work of the boys in the laundry consists of hand ironing and attendance upon the comparatively simple machines in use in modern laundries. The instructor supervises much

as does the foreman in commercial work, and also cares for the upkeep and operation of the more complicated machines. Under these circumstances the group assigned to the detail has been of lower average intelligence than those working in the previously discussed groups, median mental age 11:10. The range, however, has been fairly comprehensive, 8:0 to 16:5. For the group the correlation of mental age with trade success is —.297±.107, and inspection of the distribution revealed consistent failure for the boys whose mental ages were above 15 years. Likewise the successes are most frequent among those below the 10:6 level. The critical levels are reversed and definite. A minimum requirement of intelligence is not defined within the range represented.

Culinary Trades

1. **Kitchen.** All food except the bread and pastries made in the bake shop is prepared for serving by the kitchen. For purposes of segregation and because of the commercial opportunities after leaving the school, this detail is made up largely of negro boys.

A range of intelligence levels from 7:6 to 15:8 is included in the group, with a median mental age of 12:3. The chef failed to make use of the larger part of the rating scale, with the result that the lowest Trade Average is above the median of the ratings given by the other instructors. It is questionable whether every boy in the detail made the success indicated. However variations within the group are present altho in very slight amounts. The resulting coefficient of correlation, .093±.12, is practically zero. There seems to be little if any relation between intelligence and comparative success. However, at each extreme of the range there is a group of which the majority fail to attain to the median rating of the group. Above mental age 13:3, not a single case reached the median rating, while a similar distribution occurs below the level 9:6. Greatest success occurs between the mental ages 9:6 and 13:3, but the lowest rating as noted above is comparatively high.

2. **Bake Shop.** In the bake shop are prepared the bread and pastries (pies, cakes, cookies, doughnuts, etc.) for the dining rooms. The boys do the work of mixing the doughs, timing the rising and baking processes, and remove the completed articles from the ovens; all under the supervision and instruction of a first-class baker.

Here again the relation between mental rating and Trade Averages is practically zero, .016±.132, altho the range of rating is complete. The factor of intelligence is nearly negligible under the conditions of supervision provided in this shop.

On the other hand chronological age is a factor to be used as a

guide in the selection of boys, the coefficient of correlation with Trade Averages being .476±.102. A chronological age of 14:6 is required for reasonable expectation of success and both higher proportions and degrees of success are attained by the still older boys.

Farm Work

1-2. Dairy and Teamsters. The similarity of the statistical indications and of the diagrammatic distributions for these two details makes posible discussion of the two groups together after the duties of each have been mentioned.

The work in the dairy consists in the care of the physical equipment, barns, stalls, milk receptacles, feed and feed-bins, of the feeding of the cows, and handling of the milk after cooling and separation. The milking is done by hired milkers. Assignments are made from the dairy detail to the feeding of the hogs and the care of their pens.

The teamsters are supervised in the care of horses, wagons, and the horse barns. They drive the teams for all hauling service not handled by motor trucks, for plowing, cultivating, etc., where tractor operation is not feasible. All tractor work is done by hired help. In two cases the tractor operators have been boys who have formerly been members of the teaming detail and who have been hired after special instruction in tractor operation.

In the case of each of these groups the relation of mental age to subsequent success in the work is very small and negative (practically zero, in view of the P. E.s). Coefficients are for the dairy —.126±.118, and for the teamsters —.087±.137. The distribution of Trade Averages by mental ages consist of nearly even divisions of successes and failures at all levels from mental age 8:0 to 14:6. Chart II gives the distribution of teamster ratings and illustrates the mental relationships. In each group all boys with mental ages above 14:6 receive better than median averages. This suggests a possible upper critical Level at this point. Likewise the relation between chronological age and success is zero.

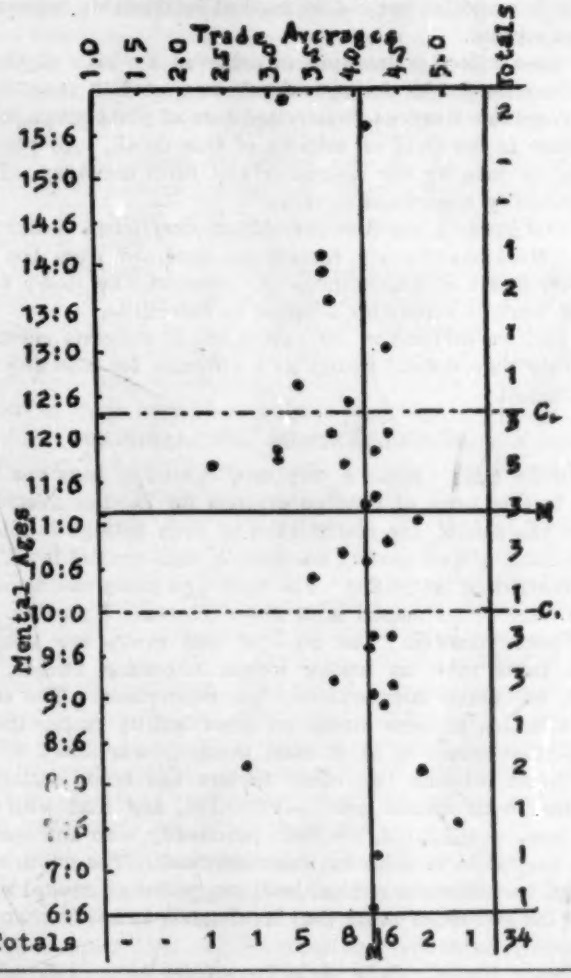
The practical suggestion is that boys between ages 13 and 19 and whose mental ages are above 14:6 can be expected to make successful progress in this work; and that for mental ages below 14:6 the expectation is about equally divided between success and failure. The minimum intelligence required is below the level of 8 years.

3. Poultry Department. Instruction is given in the feeding of poultry, breeding of pure strain stock, care of pens, handling of egg-laying and records, incubation and hatching. The instructor is an experienced chicken fancier and egg producer, but has had no training in educational methods.

CHART III

SHOE SHOP

Distribution of Trade Averages by Mental Age Levels
(Negative Relation)



LEGEND

M Median
C_1 Lower Critical Level
C_2 Upper Critical Level

The relation found between the ratings and the mental levels of those in the group shows the highest positive correlation, except one, of all the groups studied. The coefficient is .60±.092.

Two clear cut critical levels are indicated at the 12:6 level and the 10:6 division.

There is a similar but not so marked relationship between actual age and success.

The most effective learning is achieved by boys of the higher ages whose mental levels approximate or exceed 12 years 6 months.

4. **Vegetable Gardens.** Supervised care of plant propagation and cultivation is the field of activity of this detail. All planning of planting is done by the instructor and farm manager. The boys are essentially supervised workers.

For this group a negative correlation, coefficient —.243±.143, is found. Most satisfactory results are obtained from the boys of the lower levels of intelligence. As suggested by Rossy (12), this type of work is especially adapted to defectives.

The positive correlation .307, altho small, suggests chronological age rather than mental ability as a criterion for selecting workers in this detail.

Miscellaneous Unclassified

1. **Office Boys.** Altho a very small group of boys has been assigned to this work of running errands for the administrative offices of the School, the distribution of their ratings is interesting as indicating almost perfect correlation with mental level. Correlation coefficient .983±.009. The boys who made median or better success were all of mental ages above 13 years 3 months.

2. **Flower Garden.** The boys of this group are assigned to routine tasks such as hoeing weeds, trimming bushes, picking flowers, but under comparatively lax supervision. The emphasis in the selection of boys placed on dependability rather than upon other factors seems to be at least partially warranted by the relation found between two other factors and trade ratings. The correlation with mental age, —.071±.150, and that with chronological age, —.169±.146, are both practically zero and seem to be almost negligible in selection considerations. The evidence is insufficient to validate a critical level suggested at mental age 14:6. Both of the two cases above that level attain to better than median success.

3. **Power House.** Only eight boys have been assigned to the boiler tending duties of this detail. And for these boys information was given to the engineer as to their mental equipment. His ratings may not be as valid as those of the other instructors who

possessed no data except their own observation of the mental abilities of the boys. For these eight cases the Footrule correlation is found to be .247±.224.

4. **Hospital Orderlies.** The boys in this group do the routine work of keeping the hospital clean and running errands for the nurse and patients. Only seven cases are available for inspection, and for the few cases a positive coefficient with a high Probable Error was found, .414±.211. Little dependence can be placed upon this index except as possibly indicating a probable tendency.

Service Details

Under this heading are placed two details whose work is not considered as preparation for any future specific occupational employment but which may be thought of as definitely encouraging habits of industry.

1. **Housekeeping.** Under the supervision of women, small groups of boys do the janitor work in the buildings and living accomodations on the school grounds. Their duties include sweeping, scrubbing, dusting, window washing, and bed-making. This is essential routine work and is ordinarily assigned to new boys who are later detailed to more specific vocational training.

A slight negative correlation, —.147±.107, is found between success ratings and mental age levels; a similar coefficient represents the relation of chronological age to ability to do the work. The older and brighter boys find this type of work irksome. A lower critical level of 9:0 is found, while at the same time only one out of five having mental ages above 14:6 are rated as successful.

2. **Dining Room.** This detail, under close supervision, provides the service of the meals in the large central dining room for boys, cares for the cleanliness of the room, for the setting of the tables and for the dishwashing. This detail is probationary for prospective kitchen boys and for others waiting for assignments to trade groups. There is no correlation between the success ratings and the intelligence levels, coefficient being .034±.114. This distribution is chosen as representative of the neutral relationship between intelligence and Trade Averages.

Summary and Conclusions

1. From the consideration of the relation of trade learning records and the mental levels of those taking training in various occupations, the trades may be classified into three divisions on the basis of the nature of the relationship found to exist. The coefficients of correlation illustrate the three classifications as follows:

a. The **positive type,** in which there is found a positive coefficient, interpreted as meaning that the expected degree and oc-

curence of success is directly dependent on the position of the mental level of the boy on the scale of intelligence ratings. The positive coefficients are not large but sufficiently so to be definite indications that general intelligence is a factor in determining extent of success in learning fundamental trade processes. However, there are other factors of importance which influence the achievement.

b. The **neutral type**, in which the coefficient indicates a negligible relationship between mental level and potential ability to make good under the conditions described.

c. **The negative type**, in which the relationship is the reverse of the positive and indicates that the work is more adapted to those of lower levels of intelligence. Here again the size of the coefficients indicates the strong influence of other factors.

2. In accordance with the above divisions the trades groups studied may be grouped as follows:

a. Positive Type.			
Office Boys	.983±.009	Blacksmith Shop	.299±.134
Poultry Dept.	.600±.092	Paint Shop	.283±.138
Hospital Boys	.414±.211	Garage	.259±.16
Print Shop	.331±.084	Power House	.247±.224
Carpenter Shop	.306±.109	Tailor Shop	.232±.072
b. Neutral Type.			
Kitchen	.093±.120	Teamsters	-.087±.137
Dining Room	.030±.114	Dairy	-.126±.118
Bake Shop	-.016±.132	Housekeepers	-.147±.107
Flower Garden	-.071±.159		
c. Negative Type.			
Vegetable Garden	-.234±.143	Shoe Shop	-.313±.103
Laundry	-.297±.107	Plumbing Shop	-.377±.13
Book-bindery	-.305±.14		

3. Certain of the trades show positive requirements of chronological age. But partial correlations between success and mental standing eliminating the factor of actual age failed to change materially the coefficients of relationship.

4. Minimum mental requirements for a reasonable amount of success were located as follows:

Power House	13:6	Paint Shop	11:0
Office Boys	13:0	Poultry Dept.	10:6
Blacksmith Shop	12:6	Housekeepers	9:0
Print Shop	12:3		

5. In other groups successful learning was found within the limits of the range represented and the minimum was not reached, altho the lower levels of these trades were as follows:

Shoe Shop	6:6	Teamsters	8:6
Dining Room	7:6	Vegetable Garden	8:6
Kitchen	7:6	Flower Garden	9:6
Tailor Shop	7:6	Bake Shop	10:0
Dairy	8:0	Book-bindery	10:0
Laundry	8:0	Carpenter Shop	10:0
Plumbing Shop	8:6	Garage	11:6

These findings are important as verifying on a statistical basis the fact that persons of limited mental qualifications can take part in the constructive, useful work of society and, in the case of the "negative type" occupations, with more efficiency than those of higher intelligence, **provided proper supervision is given.**

6. Four groups gave reversed critical levels such that 75% or more of failures occured at mental levels higher than those indicated: Shoe Shop 12:3, Kitchen 13:3, Housekeepers 14:6, and Laundry 15:0.

7. Median or better Trade Averages in 75% or more of cases were found as follows:

Print Shop	above 15:0	Paint Shop	above 14:0
Dairy	above 14:6	Office Boys	above 13:0
Book-bindery	above 14:0	Poultry Dept.	above 12:6
Dining Room	above 14:0		

Shoe Shop	between 6:6 and 10:0
Kitchen	between 7:6 and 9:6
Laundry	between 8:0 and 10:6
Book-bindery	between 10:0 and 12:0

8. The general conclusions are that

a. general intelligence is a factor which influences trade success during the learning stages in different degrees, depending on the trade and the conditions of instruction;

b. in no group is the degree or fact of success wholly dependent upon intelligence;

c. lack of a certain degree of intelligence may prevent attainment of a given degree of success;

d. in a few trades and occupational groups statistical treatment of data indicates that general intelligence is practically negligible;

e. the use of general intelligence measures as an aid to specific trade learning assignments is justified if sufficient care is taken in the interpretation of these ratings and if the relative value of other factors is also considered; and

f. there is need for careful study and analysis of the other factors which assist general intelligence in the determination of potential trade ability.

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MENTAL FATIGUE OF MIXED AND FULL BLOOD INDIANS.

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University of Denver

A group of Indians composed of mixed and full bloods showed a tendency to more successfully resist the onset of mental fatigue than did whites or negroes of about the same education and age. The questions now presenting themselves are as follows:

1. Do full bloods of these groups fall away in this performance less than mixed bloods?
2. Do mixed bloods fall away less than whites?
3. As the continuous performance proceeds, what is the status of the several groups at any certain point for the curves of work when brought into relation; i. e., do any of these groups tend to hasten through sooner than others as indicated by per cent of total work done?
4. Incidentally, is the Indian's tending to resistance of the onset of fatigue here found accompanied by any conscious state indicative of this resistance, granting that the introspections obtained have any degree of reliability in such young and inexperienced subjects?

Having these questions in mind, we proceed to examine some of the data referred to above and reported by the writer in the Journal of Applied Psychology, Vol. IV, pp. 235-244 and Vol. V, pp. 14-25 under the titles, "Racial Differences in Mental Fatigue" and "White, Indian and Negro Work Curves."

In these articles we have already described the subjects to some extent, explaining that the Indians were of certain tribes, mostly Cherokees, Creeks, Cheyennes, and Choctaws. In fact we may safely class them as Plains and Forest Indians in contradistinction to the Plateau Indians living farther to the southwest whose origin is somewhat different. Educators working with Indians of various tribes claim to find great differences in mental capacities among the different tribes. For these and other reasons the groups forming subjects for this experiment cannot be taken as representing all the American Indian racial stocks.

There were in the original Indian groups 106 full bloods and eighty mixed bloods who were given a continuous mental task running through twenty-eight minutes for the younger sub-groups

and forty-two minutes for the older sub-groups. When we regroup these according to blood, we have in the full blood older sub-groups 47 subjects and in the younger, 61 subjects, while of the mixed bloods there are for older ones 49 subjects, and for the younger, 30. The twenty-eight and forty-two minute periods were broken up into periods of two minutes each. The records were so made that a measure of each individual's performance for any two minutes was easily obtained. These were totalled; his performance for any period was then expressed as a per cent of his total performance in the total working time. This gives an individual work curve in per cents. (See Garth, Mental Fatigue During the Continuous Exercise of a Single Function, Archives of Psychology, No. 41.) The individual work curves were then averaged, giving curves for full bloods of older Indians and of younger Indians, and

TABLE I

SHOWING ATTEMPTED PERFORMANCE

	3rd and 4th Grades						7th and 8th Grades					
No. of Cases	Mixed Bloods 31			Full Bloods 61			Mixed Bloods 51			Full Bloods 47		
Period	Av%	AD	PE	Av%	AD	PE	Av%	AD	PE	Av%	AD	PE
1	8.2	1.9	.3	6.9	1.5	.2	5.0	.5	.06	4.8	.7	.1
2	6.9	.9	.1	6.9	1.3	.1	4.5	.5	.06	4.6	.7	.1
3	7.4	1.0	.1	6.9	1.2	.1	4.5	.5	.06	4.5	.5	.07
4	7.0	.8	.1	7.1	1.5	.2	4.8	.6	.07	5.3	1.1	.2
5	7.0	1.4	.2	6.5	1.4	.2	4.6	.5	.06	4.4	.7	.1
6	7.9	1.0	.1	7.4	1.2	.1	4.7	.3	.03	4.4	1.0	.1
7	7.4	1.5	.2	6.2	1.3	.1	4.4	.6	.07	4.4	.5	.07
8	7.0	.4	.1	7.2	1.3	.1	4.8	.4	.05	5.0	.6	.08
9	6.7	.8	.1	6.3	1.2	.1	4.5	.5	.06	4.4	.6	.08
10	7.2	.3	.05	7.7	1.5	.2	4.5	.6	.07	4.7	.5	.07
11	7.2	.4	.1	7.9	1.5	.2	4.4	.4	.05	4.6	.6	.08
12	7.2	1.7	.3	7.1	1.4	.2	4.5	.2	.02	4.5	.7	.1
13	7.4	1.3	.2	7.8	1.5	.2	4.7	.4	.05	4.7	.2	.03
14	7.1	1.7	.3	7.2	.8	.2	4.2	.4	.05	4.5	.7	.1
15							4.6	.5	.06	4.7	.6	.08
16							4.2	.5	.06	4.4	.6	.08
17							4.5	.8	.1	4.8	.6	.08
18							4.6	.3	.03	5.2	.6	.08
19							4.6	.9	.1	5.0	.3	.04
20							4.7	.4	.05	5.0	.6	.09
21							4.7	.5	.06	4.9	.7	.09
Total	53.3	5.1	.9	50.9	15.2	1.7	118.0	22.8	2.8	113.0	23.5	3.4
First 3	22.6			21.0			14.1			14.4		
Last 3	22.0			22.1			14.0			14.8		
First ½	51.9			48.2			51.2			51.3		
Age 13⁷/₁₂ yrs.		2.2	.9	15.7	1.2	.9	16.8	1.6	.8	17.3	2.5	1.0
First 3												
Last 3 =	.977			1.068			.99			1.059		
	(or 2.3% loss)			(or 6.8% gain)			(or 1% loss)			(or 5.9% gain)		

for mixed bloods of older and of younger subjects, making curves for the four sub-groups as indicated above. There were two categories, the attempted performance—viz., per cents of total columns of addition attempted,—and accurate performance—being per cents of total columns actually right, which gives two curves for each blood sub-group—an attempts curve and an accurate curve. See Tables I and II.

TABLE II

SHOWING ACCURATE PERFORMANCE

	3rd and 4th Grades						7th and 8th Grades					
No. of Cases	Mixed Bloods 31			Full Bloods 61			Mixed Bloods 51			Full Bloods 47		
Period	Av%	AD	PE	Av%	AD	PE	Av%	AD	PE	Av%	AD	PE
1	9.1	4.1	.6	6.7	4.0	.4	5.3	2.2		5.2	2.4	.4
2	5.1	2.2	.3	6.5	3.7	.4	4.6	1.9		4.6	2.8	.5
3	9.1	3.8	.6	7.4	2.8	.3	5.1	1.2		6.5	2.4	.4
4	8.3	4.8	.7	7.1	3.7	.4	5.6	1.3		6.2	3.1	.5
5	7.4	3.7	.6	9.1	6.0	.7	5.8	.3		5.4	1.9	.3
6	7.1	2.0	.3	6.7	2.7	.3	5.3	1.9		5.7	2.4	.4
7	5.8	3.6	.6	6.6	4.3	.5	4.8	1.2		4.6	2.1	.3
8	3.8	.5	.1	9.2	4.8	.5	5.5	1.8		5.6	2.6	.4
9	5.8	1.4	.2	5.2	3.0	.3	3.9	1.1		4.7	2.3	.4
10	8.1	3.3	.5	7.6	4.4	.4	5.2	1.5		6.5	2.5	.4
11	7.0	3.6	.6	8.0	4.3	.4	4.6	1.5		5.2	2.3	.3
12	6.4	2.6	.4	7.0	4.0	.4	4.6	1.8		4.8	2.1	.3
13	7.6	3.2	.5	7.3	2.8	.3	4.9	1.5		6.2	2.7	.4
14	5.9	2.6	.4	6.2	3.3	.4	4.2	1.6		4.2	1.8	.3
15							4.2	1.8		5.3	2.8	.5
16							3.5	1.2		4.0	2.2	.3
17							5.4	1.6		6.1	2.9	.4
18							4.1	1.1		5.4	2.4	.4
19							5.5	1.6		5.0	2.2	.3
20							4.8	1.7		5.7	2.3	.3
21							4.4	1.7		5.5	2.8	.5
Total	28.1	10.6	1.7	29.0	13.4	1.47	69.4	22.4	9.7	64.1	18.4	3.4
First 3	23.6			20.6			15.1			14.4		
Last 3	19.9	..		22.3	..		14.7	..		14.5	..	
First ½	55.2	..		48.5	..		55.6	..		53.4	..	
First 3 / Last 3	= .81	..		1.083	..		.976	..		1.003	..	
	(or 19% loss)			(or 8% gain)			(or 2.4% loss)			(or 3% gain)		

The tables presenting the Indian data for the categories and sub-groups just described are given herewith and are composed of averages and measures of variability for any group's per cents for any successive two minutes.

While the tables give all the facts just mentioned, we have thought it well to derive curves from same in order to supply a graphic representation of these facts. In addition, we have taken

the curves for whites in the above mentioned articles (Ibid.) and placed them beside the full and mixed blood Indian curves. The curves are smoothed out by averaging the performance of each four successive minutes. Despite the small number of cases, the curves are fairly well smoothed out excepting for the younger mixed blood sub-group in the accurate performance.

Whites ——— Mixed Bloods o—o—o Full Bloods . . . .
Attempted Performance

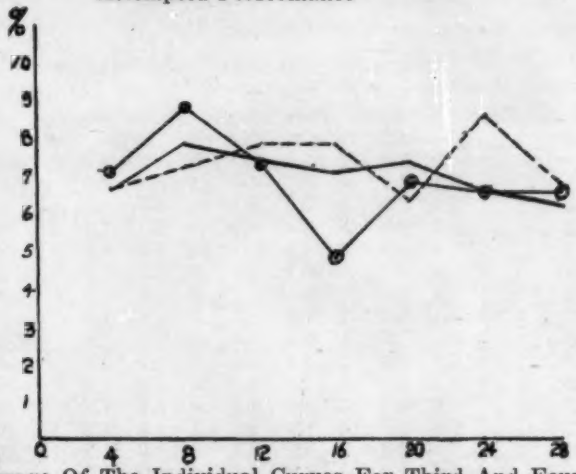

Fig. 1. Average Of The Individual Curves For Third And Fourth Grade Subjects.

Whites ——— Mixed Bloods o—o—o Full Bloods . . . .
Accurate Performance

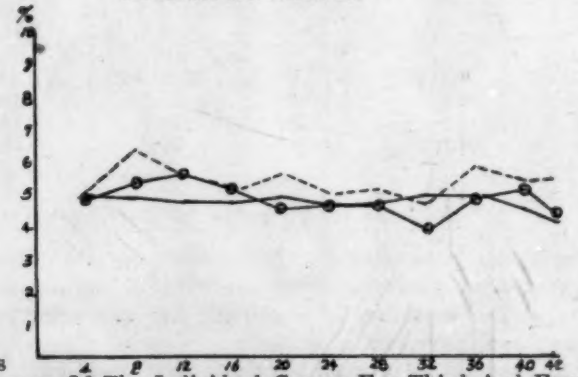

Fig. 2. Average Of The Individual Curves For Third And Fourth Grade Subjects.

Whites ——— Mixed Bloods o—o—o Full Bloods . . . .

Attempted Performance

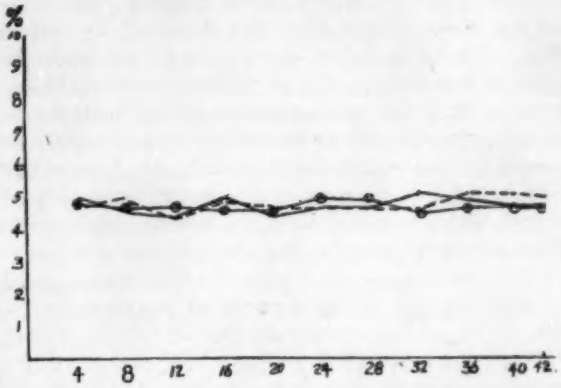

Fig. 3. Average Of The Individual Curves For The Seventh And Eighth Grade Subjects

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Whites ——— Mixed Bloods o—o—o Full Bloods . . . .

Accurate Performance

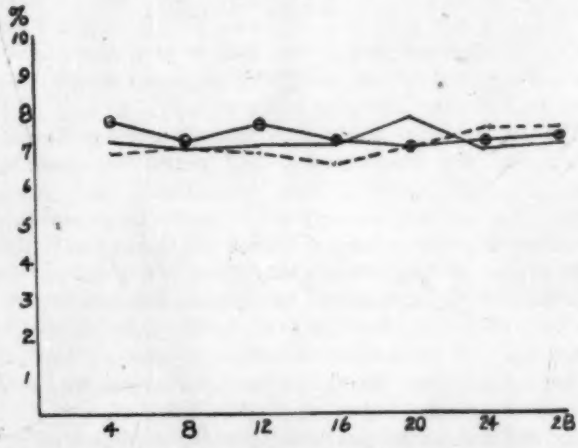

Fig. 4. Average Of The Individual Curves For The Seventh And Eighth Grade Subjects

In all the curves the Indian subjects hold up better than the whites at the end with the exception that the curves for attempted performance for the mixed bloods and the older sub-group occupy about the same points. With this exception we find the full bloods at the end holding out in the curves better than the whites, and the mixed bloods occupying a position between them.

In order to obtain some measure of the falling away of a group in its performance, the same method was used here as was used in the work by the writer mentioned above (Archives of Psychology, No. 41, p. 18) i. e., comparing the amount done in the first six minutes with that accomplished in the last six minutes of work.

These numbers were for the younger sub-groups:

In Attempts		In Accurates.	
Full Blood Indians	gained 6.8%	Full Blood Indians	gained 8.0%
Mixed " "	lost 2.3%	Mixed " "	lost 19.0%
Whites	lost 3.0%	Whites	lost 17.0%

The comparative extreme loss of the mixed bloods in accurates is due to their initial spurt which may be noted in the curve. It is possible this would not appear if a larger group of mixed blood subjects had not been obtainable. We have already called attention to the fluctuations in this curve.

For the older subjects these numbers are:

In Attempts		In Accurates	
Full Blood Indians	gained 5.9%	Full Blood Indians	gained 0.3%
Mixed " "	lost 1.0%	Mixed " "	lost 2.4%
Whites	lost 4.0%	Whites	lost 10.2%

This comparison favors the full bloods most and the whites least, the mixed bloods occupying an intermediate position in respect to a falling away in performance.

We call attention to the fact that the average age of the mixed bloods was, for lower grades, 13.7 years; for upper grades, 16.8 years; for full bloods it was, respectively, 15.7 years, and 17.3 years. For the whites engaged in a similar experiment the ages for the two grade sub-groups were on the average, 9.9 years and 14.05 years. It might be objected that the disparity in ages could account for the differences in fatigue, but the writer found for the data of an age for age comparison through the groups were quite small, of whites and Indians, the tendency was still in favor of the Indians (See Racial Differences in Mental Fatigue, Garth, Journal of Applied Psychology, 1919, Vol. IV).

The differences brought out by these comparisons of the curves and the falling away in performance as measured by comparing the first and last six minutes of work are not sufficient evidence of tendencies to differ in the group measures, but it will be necessary

to measure the overlapping of one distribution on another before these differences as given here are truly and significantly evaluated. While the overlapping of these "fatigue" measures cannot be secured here, we do what will probably prove just as much worth while and in doing so we bring out some facts thus far not noted. To do this we tap the curves at various points. Let the question be, in the first place, "Are the full and mixed blood curves similar or different?" In order to answer this question, we must seek the distributions whose averages compose the curves and superimpose one of the two to be compared on the other and thereby determine the amount of overlapping.

But there are too many distributions to make this a practical undertaking, so instead of doing that we tap the curves (See Journal of Applied Psychology, Vol. V, pp. 14-25) say at these points: at the beginning, at the middle, and at the end and obtain distributions for per cent of work done in first six minutes, in first half of total working period, and in last six minutes. The distributions are not given here, but only the medians and the numbers indicating the per cent of mixed bloods attaining and exceeding the

TABLE IIIA

SHOWING YOUNGER INDIAN SUBJECTS, THIRD AND FOURTH GRADES

	First 6 Minutes				First 14 Minutes				Last 6 Minutes			
	Attempts		Accu.		Attempts		Accu.		Attempts		Accu.	
	F.B.	M.B.	F.B.	M.B.	F.B.	M.B.	F.B.	M.B.	F.B.	M.B.	F.B.	M.B.
No Cases	61	30	58	31	61	30	58	30	61	31	58	31
Med.	20.5	21.3	19.3	23.0	48.3	48.5	49.5	50.0	22.5	22.0	20.3	19.8
% of M. B. Att. Med of F. B.		51%		71%		53%		63%		54%		47%
Ave.	21.4	22.6	20.6	23.6	48.2	51.9	48.5	55.2	22.1	22.0	22.3	19.5
A. D.	2.8	3.9	3.1	9.1	3.6	7.1	3.3	9.2	3.2	4.0	8.8	8.2
P. E.	2.0	3.1	2.4	7.2	2.7	6.3	2.5	7.6	2.5	3.2	7.0	6.9
								Gain 6.8%	Loss 2.3%	Gain 8.0%	Loss 19.0%	

full blood median in any distribution. Tables (III) A and B give the numbers. Table (IV) gives the white median, obtained in a previous experiment (Ibid.) and the overlapping of the median of the Indian sub-groups on the several white distributions.

In the first six minutes, then, in the case of the Indians, the mixed bloods excel the full bloods in medians and averages, and the overlapping is in their favor in all cases. In the first half of the performance (work of first fourteen minutes for the younger subjects and twenty-two minutes for the older) these measures indicate that the mixed bloods were still doing more of their work at this stage of the performance than the full bloods, with the ex-

TABLE IIIB

SHOWING OLDER INDIAN SUBJECTS, SEVENTH AND EIGHTH GRADES

	First 6 Minutes Attempts		First 6 Minutes Accu.		First 22 Minutes Attempts		First 22 Minutes Accu.		Last 6 Minutes Attempts		Last 6 Minutes Accu.	
	F.B.	M.B.	F.B.	M.B.	F.B.	M.B.	F.B.	M.B.	F.B.	M.B.	F.B.	M.B.
No. Cases	46	47	48	49	47	49	47	49	47	49	47	49
Med.	14.4	14.8	14.0	15.8	51.4	51.0	53.0	5.8	15.2	14.2	14.8	13.8
% of M. B. Att. Med. of F. B.		61%		59%		49%		59%		33%		42%
Ave.	14.0	14.1	14.4	15.1	51.3	51.2	53.4	55.6	14.8	14.0	15.4	14.7
A. D.	1.5	1.4	3.0	3.3	2.7	2.5	5.7	5.6	1.5	1.4	3.0	4.1
P. E.	1.2	1.1	2.4	2.6	2.2	2.0	4.6	4.5	1.2	1.1	2.4	3.3
								Gain 5.9%		Loss 1.0%		Gain .3%		Loss 2.4%

TABLE IV

SHOWING CENTRAL TENDENCIES FOR WHITES AND THE INDIAN OVERLAPPING

	Per Cent of Work Done in: First 6 Minutes Att.	Acc.	First 14 Minutes Att.	Acc.	Last 3 Minutes Att.	Acc.
Whites 3rd and 4 th Grades No. Cases 368	Med. 21.81	22.41	50.28	51.52	21.59	19.82
Indians 3rd and 4th Grades						
% Attaining Med. of Whites	M. B. 50%	44%	50%	50%	68.1%	54.8%
	F. B. 47%	28.5%	39.6%	38.6%	58.5%	70.4%
Whites 3rd and 4th Grade No. Cases 343	First 6 Minutes Att. Med. 14.9	Acc. 15.1	First 22 Minutes Att. 53.02	Acc. 54.7	Last 3 Minutes Att. 14.9	Acc. 14.1
Indians 7th and 8th Grades						
% Attaining Med. of Whites	M. B. 52%	50%	51%	48%	38%	50%
	F. B. 35%	48.5%	31%	44%	56%	63%

ception of the medians for attempts in the older groups where the blood groups are about even. This would indicate that generally the mixed bloods were doing more of their work in the first half of the period than the full bloods. In the last six minutes these same measures: median, average, and that of overlapping, indicate that the full bloods resist the fatigue at the end better than the other blood group with the exception of those of the younger group in attempts for here the overlapping indicates that 50 per cent of the mixed bloods attained and exceeded the median of the full bloods.

We believe that these two defects, as shown in the overlapping, would be removed by testing larger numbers.

When we compare the Indian groups with the Whites—see Tables—the case is clearer for the full bloods as a result of taking medians and measures of overlapping. Here, the tendency for the whites to do more of their work at first and by the middle of the total time of working and less at the end than the full bloods is constant But the numbers are not conclusive for the mixed bloods. (See table for overlapping on white distributions)[1]. All we can say here is that the younger mixed bloods are similar to the whites in the first half of their performance, but somewhat better at the end and as for the older mixed bloods, the performance is similar in the first half in both categories and in accurate performance it is likewise similar at the end but not so in the attempted performance at this point.

The differences, then, are more definite between the full bloods and whites, and full and mixed bloods, than between the whites and mixed bloods.

The fourth question raised at the beginning of this discussion was as to whether the ability to resist the onset of fatigue as indicated by objective measures of the efficiency of the process here being examined, was indicated, in any way, by subjective states, i. e., by introspection, if the reports of these subjects may be taken as having reliability. In order to investigate this problem, the experimenter at the close of the experiment with the Indians requested the subjects to write on the back of the record booklet whether they were (1) Not tired, (2) Tired, (3) A little tired, or (4) Very tired. The results are interesting but rather confusing.

The reports range from a statement like the following, "I was tired, my arms surely did hurt," the writer of which was a full blood Indian girl whose accurate performance at the close was as good as at the beginning and who attempted more (22 per cent) at the close than she did at the beginning; to that of a quarter blood Caddo boy, who says he was not tired yet fell off 10 per cent in attempts and 76 per cent in accurates. The answers to the question as to whether the members of the group were tired may be summed up as follows:

---

[1]Per Cent Attaining Median of Whites

		First six	First half	Last six
Young F.B.	Att:	47	39.6	58.6
	Acc:	28.5	38.6	70.4
Young M.B.	Att:	50	50	68.6
	Acc:	44	50	54.8

Per Cent Attaining Median of Whites

		First six	First half	Last six
Old F.B.	Att:	35	31	56
	Acc:	48.5	44	63
Old M.B.	Att:	50	51	38
	Acc:	50	48	50

MIXED BLOODS

Reporting	Grades 3 and 4 No.	Per cent	Grades 7 and 8 No.	Per cent
Not tired	20	64	31	62
Little tired	8	26	15	30
Tired	0	0	4	8
Very tired	2	7	0	0
No report	1	3	0	0
Total	31	100	50	100

FULL BLOODS

Reporting	Grades 3 and 4 No.	Per cent	Grades 7 and 8 No.	Per cent
Not tired	26	44	20	42
Little tired	25	43	25	52
Tired	0	0	2	4
Very tired	5	9	1	2
No report	3	4	0	0
Total	59	100	48	100

It will be seen from looking at the above that over half (62 per cent) of the mixed bloods gave "not tired" as a statement of their "feelings" and that only 43 per cent of the full bloods gave this report. This would seem to show that as a group the former are poorer introspectionists than the latter, or that the resistance to fatigue may be present as a physiological fact or even absent, without the subject's being aware of it, for the mixed bloods as a group suffered more, fell away more, than the full bloods, i. e., in both the older and younger groups and in both attempts and accurates the full bloods gained (see above), and the mixed bloods lost. Over one-half of the mixed bloods reported "not tired" and 57 per cent of the full bloods reported "tired," and yet the former were doing a smaller part of their own work than the latter in both groups in both categories excepting in the 3rd and 4th groups (with 54 per cent overlapping favoring them—see table), if we take the median full blood performance as a measure. Now as for the full bloods if the median performer was doing 22.5 per cent of his total work and 20.8 per cent of his total work, respectively, (in each of the two categories reported) in the younger group; and 15.2 per cent and 14.8 per cent of his work in the older group, and 56 per cent and 58 per cent of the other group reported tired, when the fact is, they were doing as well and better than at the start, i. e., over 62 per cent of those in the younger, and 57 per cent of the older of them, we have to conclude that these full bloods either exaggerated their fatigue or had strenuous work keeping at the performance—putting forth more effort and getting better results than the mixed bloods.

We are here hovering around the problem of the reality of the old traditional stoicism of the Indian. Is this resistance to fatigue real stoicism, is it native, is it acquired? If their resistance was effortful and consequently conscious, it was not real stoicism, since stoicism is indifference to pleasure and pain, a stoic being an apathetic person. But it was due to effort if we take into consideration the objective measures and the frank statement of awareness of fatigue. If it is native it cannot be of the order of instinct, since it is marked by effort, but must be of a high order of native equipment. Sustained effort is said to mark the mental process of the genius. (See Woodworth, R. S., Dynamic Psychology, p. 132).

In conclusion, then, we may say:

These full blood Indians of Forest and Plains groups resist the onset of fatigue more successfully than the mixed bloods whose blood is of the same Indian stock.

The mixed blood performance is more like the white performance than that of the full bloods.

The latter's curves suggest an intermediate position at the end between the full bloods and whites, i. e., both whites and mixed bloods tend to hasten through their tasks sooner than the full bloods.

As introspectionists the full blood Indians are more inclined to acknowledge fatigue than the mixed bloods. This indicates a willingness to put forth effort in larger degree than was found in the mixed bloods.

INDIVIDUAL INJUSTICE AND GUESSING IN THE TRUE-FALSE EXAMINATION.

By J. Crosby Chapman
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On a relatively difficult fifty item True-False examination recently given by the author, a striking illustration of the unreliability of chance and the injustice done to the individual by too great reliance upon its neutralizing effect, was forthcoming. In spite of the directions which called for guessing on the unknown items, one of the subjects, after having done fourteen examples, called the examiner and said that these fourteen examples marked the limits of knowledge. Of these fourteen items, thirteen were correct. In order to simplify the marking, however, the subject was told to guess on the remaining items. When the paper was marked on the right minus wrong basis the final score of the subject was zero. While this case is undoubtedly very exceptional, the possibility of a subject's score changing from twelve to zero within a group in which the semi-interquartile range was 8.5 is, from the standpoint of reliability and individual justice, a most serious matter. That this result was not produced by elements in the test which were misleading, thereby tempting an ignorant person to make the incorrect response, was shown by the response of the other subjects which within the limits of chance tended to give on the difficult questions a fifty fifty ratio.

Kohs[1] in a paper entitled "High Test Scores by Sub-Average Minds," has shown the extent to which pure guesing in a test consisting of fifty items fails to produce a zero score. By expending the binomial theorem, he proves that the possibility of scoring plus or minus 10, on the Right minus wrong basis, is .084. He therefore justly calls in question the comfortable notion, expressed by McCall[2] in his article entitled "A New Kind of School Examination," that by the sure operation of chance guessing will eliminate itself. Whereas McCall implies that there is an extremely high probability that guessing will eliminate itself on a test of fifty items, Kohs shows that the half right and half wrong result will only occur once in every ten chances.

In spite of this objective evidence, McCall in his most interesting

[1]Psych. Bulletin, January, 1920, page 3.
[2]Jour. Educ. Research, January, 1920, p. 33 ff.

book, entitled "How to Measure," has not corrected the false impression that guessing will correct itself on a test consisting of the number of items which may reasonably be expected in this form of examination.[3] That this is not the result of merely loose expression of an idea, but is the outcome of an erroneous impression with regard to the operation of chance, is shown by the following statement, published in the original article and again republished in the book; which McCall presents to support his main thesis with reference to limited guessing:

> "It is very difficult for some people to believe that such a test as has been outlined above does anything more than give the highest score to the luckiest guesser. They look with the eye of suspicion on this thing they call chance. I once tossed pennies for heads or tails, 50,000 times. The results came out 25,000 heads and 24,999 tails. Had there not been a miscount somewhere, the two would doubtless[4] have come out exactly even."

Making due allowance for poetic licence with regard to the historicity of the experiment, the final statement is incorrect, and shows a failure to appreciate the significance of chance. No one can deny that in the tossing of 50,000 coins, 25,000 heads and 25,000 tails may result, but that they would have been certain to result, had there not been a miscount, is a mathematical fallacy. That 25,000 heads and 25,000 tails will be a more likely result than any other is correct, but that it will not be a certain result is obvious. In fact we can calculate the exact chance of an even break in the tossing of 50,000 coins. Using the formula expressing the standard deviation of the number of successes in events $\sigma = \sqrt{npq}$. In this case $n = 50{,}000$ while $p = q = \frac{1}{2}$. σ is therefore approximately equal to 112. By taking the reciprocal of this quantity and referring to the normal probability curve, it will be found that the coins break even only once in approximately 280 times. The sureness therefore of which McCall writes is a sureness that occurs once in 280 times! That this statement, published in 1920, has gone unchallenged and been repeated by the same author in 1922 shows the need for correcting some of the current popular notions with reference to such problems.

In Koh's article dealing with the case of fifty items, pure guessing is assumed. This guessing on the complete number of items rarely if ever occurs in practice. The subject taking the test is sure usually of a considerable number of the items, and has merely to guess or seem to guess on the remainder. In the following

[3] "How to Measure" Macmillan, 1922, Page 123.
[4] Italics my own.

theoretical discussion, I have made the assumption that a group of 100 subjects are given tests consisting of 30, 60, and 90 elements; and I have supposed in accordance with the usual fact that the pupils without guessing would range from a score of 20 per cent to a score of approximately 72 per cent of the total, distributing themselves between these extremes according to an approximation to the Gaussian curve. The reason for choosing a test of 30, 60, and 90 items is that 30 is probably as low a number as would likely be used by any reliable experimenter, though I myself, at one time failing to appreciate the significance of guessing, actually employed a test of 25 items; 50 or 60 items would be more common, and 90 would be probably the limits of ordinary practice. Knight[5] in a recent article uses 43 statements, while Gates[6] uses 30 or more statements. Yale has employed in psychology, engineering and physics tests from 20 to 30 items. In practical work twenty to forty items seems common, though the Columbia examination, in which guessing is discouraged, uses as many as 141 items.

Let us return to the consideration of the hypothetical examination made up of 30 items, where the individuals distribute themselves, eliminating guessing, over a range of scores extending from 6 to 22. The 3 individuals who know 6 items are therefore compelled to guess on the remaining 24 items, and we shall assume for purposes of convenience that this is random guesing. Twenty-four coins, therefore, were tossed, heads being counted as successes and tails as failures. By subtracting the failures from the successes and adding the positive or negative quantity thereby derived to the true score of six, we obtain the score which the individual would actually get as the result of knowledge plus guessing. In the case of the 12 individuals who without guessing would all make a score of 10, their score including guessing would by actual tossing on the remaining 20 items be 6, 2, 6, 4, 8, 6, 14, 10, 4, 10, 8, 6. In these 12 cases we have an excellent illustration of the way in which guessing fails to eliminate itself. Individuals who by hypothesis have really the same score of 10 without guessing, range all the way from 2 to 14, when the guessing factor on the remaining 20 items is allowed to enter. By continuing the process for the 100 individuals we get for each of these individuals two records, (1) the score without guessing, (2) the score with guessing. These data for the hundred subjects have been combined in Correlation Table 1.

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[5]F. B. Knight: Data on the True False Test as a Device for College Examination. J. of Ed. Psych., February, 1922, page 75.

[6]Arthur I. Gates: The True-False Test as a means of Achievemnt in College Courses. J. of Ed. Physch., May, 1921, page 296.

TABLE I

$r = .73$

SHOWS, FOR 100 CASES, THE RELATION BETWEEN TRUE SCORE AND TRUE SCORE AND GUESSING

True Score and Guessing	True Score 6	8	10	12	14	16	18	20	22
2			1	1					
4	2	1	2	1					
6	0	2	4	2	1				
8		1	2	1	2				
10	1	2	2	4	1	2	1		
12		1		3	6	3		1	
14			1	3	4	3	3		
16				1	3	4	1		
18				2	2	3	0	1	1
20					1	1	4	4	
22							2	1	1
24						2	1		1
Cases	3	7	12	18	20	18	12	7	3

A glance at this table shows how very grave may be the injustice introduced by forced guessing. The individuals with a true score of 12 will after guessing vary all the way from 2 to 18, a range of 16 points, which is equal to the total range of true scores. Furthermore, in only 19 out of the hundred cases does guessing neutralize itself. Below is shown in the hundred cases the extent to which deviations from the true score result.

Deviations for true score	-10	-8	-6	-4	-2	0	2	4	6	8	10
Percentage occurence (actual)	1	5	8	14	21	19	17	9	4	2	0
(theoretical)	1	3	6	12	18	20	18	12	6	3	1

The correlation resulting from Table I, between true score and score with guessing admitted is .73 . In estimating the reliability of an examination of this kind, when the guessing factor is allowed to enter, the appreciable lowering of the correlation coefficient must be given very careful consideration. It represents a correction which must be applied when considering the merits of the True-False examination as compared with other forms of procedure.

In case the criticism may be made that the fact of taking one hundred cases itself introduces a chance factor, and that the correlation of .73 between actual score and score plus guessing is itself an unfortunate chance, I have calculated for the same range of score and the same number of items test the correlation for 10,000 cases. In this case the tossing was eliminated and the binomal expansion used. By employing the formula

$$ {}_nC_r = \frac{\lfloor n}{\lfloor n \lfloor n-r} $$

and using the table of factorials given by Van Ostrand[7], the necessary calculations were considerably reduced. I have merely worked to approximations, using Crelle's tables. An inspection of the scatter of these 10,000 cases in correlation table II shows again how great may be the injustices. In 10,000 cases, individuals whose

TABLE II

SHOWS, FOR 10,000 CASES, THE RELATION BETWEEN TRUE SCORE AND SCORE AND GUESSING

r = .71

True Score and Guessing	True Score 6	8	10	12	14	16	18	20	22
-8	1								
-6	3	2							
-4	8	5	2						
-2	18	11	6	1					
0	31	26	18	5					
2	47	50	45	19	3				
4	60	78	90	60	15	1			
6	65	101	145	124	54	10			
8	60	109	193	212	132	39	3		
10	47	101	212	291	240	106	20	1	
12	31	78	193	323	348	213	65	6	
14	18	50	145	291	390	322	147	29	1
16	8	26	90	212	348	365	234	77	13
18	3	11	45	124	240	322	272	134	44
20	1	5	18	60	132	213	234	161	88
22		2	6	19	54	106	147	134	109
24			2	5	15	39	65	77	88
26				1	3	10	20	29	44
28						1	3	6	13
30								1	1
Cases	401	655	1210	1747	1974	1747	1210	655	401

true score should be 6, will by unfortunate and fortunate guessing range from —8 to +20. In 2,000 odd cases out of the 10,000 cases, guessing will neutralize itself. The correlation for this theoretical distribution of 10,000 cases between the true score and score and guessing is .71 which agrees very closely with .73 obtained by actual tossing of coins. The deviations from true score in 10,000 cases produced by guessing factor are shown.

Deviations	—14	—12	—10	—8	—6	—4	—2	0	2	4	6	8	10	12	14
In 10,000 cases	6	23	85	269	640	1203	1771	2006	1771	1203	640	269	85	23	6

So far we have been considering a test of 30 items. As most writers have recognized, the factor of guessing is reduced with an increase of the number of items. Making the same relative assumptions for a 60 item and 90 item test with regard to range of

[7]Tables of the Exponential Function and of the Circular Line and Cosine to Radian Argument.
C. E. Van Ostrand: Memoirs National Academy of Science, Vol. XIV. Fifth Memoir.

score without guessing and distribution within this range of score, I have empirically, by the tossing method, determined the relationship between the same factors, the true score and the score with guessing. To economize space these results have not been presented in correlation tables; they have been left in the original order and form derived. The first column shows the true score, the second column the frequency; the remaining figures on each line, coming from each successive toss, show the score after the guessing factor has entered.

TABLE III

SHOWS TRUE SCORE AND SCORE AFTER GUESSING FOR 100 CASES IN A 60-ITEM TRUE-FALSE TEST.

Score	Frequency	True Score and Guessing
12	1	2
14	1	24
16	3	4 16 18
18	4	24 20 12 20
20	6	20 22 26 28 14 20
22	8	26 26 24 16 24 18 28 28
24	10	14 22 28 28 20 20 24 20 26 22
26	11	32 22 28 28 28 20 24 18 34 30 26
28	12	36 30 18 26 36 24 34 22 28 32 34 34
30	11	26 32 36 24 32 18 22 24 30 24 34
32	10	32 28 36 34 36 38 28 32 32 34
34	8	32 36 32 34 38 34 34 42
36	6	36 36 38 36 34 40
38	4	30 40 34 44
40	3	44 40 42
42	1	48
44	1	52

r = .83

That the factor of individual injustice has by no means departed even when we reach a test of 90 items, a casual examination of Table IV will demonstrate. That the guessing is considerably reduced is shown by the significant rise in correlation from .71 to .83. The fact that the correlation in the case of 90 items is lower than in the case of 60 items is again merely another illustration of the entrance of chance in a hundred tosses. It should if repeated with a larger number of cases show of course a relatively higher correlation. Absence of interest and laborious arithmetical calculation has prevented me from determining theoretically the correlation for the 60 and 90 items.

The deviations from the true score produced in 100 individuals by guessing on a 60-item and 90-item true false test are shown:

Deviations	−14	−12	−10	−8	−6	−4	−2	0	2	4	6	8	10	12	14	16
60-item test		2	3	4	8	10	7	17	18	12	12	6	1			
90-item test	3	0	3	4	13	9	19	11	6	3	12	9	3	3	1	1

The caveat which might be issued as a result of this short study is that caution must be used in admitting the guessing factor to enter into a test. This can be done, as has already been demon-

strated, by informing the subject that he can either omit or mark as uncertain any of the items which he desires. By making the penalty for errors sufficiently great we can probably deter the wise, but we shall lower the reliability. There is a limit to which penalizing may be carried, for if it becomes too severe it may result in the test being more diagnostic of intellectual caution than of range of information. There will always be in any considerable group a number of individuals whose sporting tendency will prevent them from following the instructions not to guess. In the

TABLE IV

SHOWS TRUE SCORE AND SCORE AFTER GUESSING FOR 100 CASES AND IN A 90-ITEM TRUE-FALSE TEST.

True Score	Frequency	True score and Guessing.
18	1	26
20	1	22
22	1	20
24	2	32 22
26	2	22 34
28	3	24 22 24
30	4	36 38 24 38
32	5	38 24 26 18 30
34	6	42 32 30 46 24 28
36	6	38 28 40 36 42 34
38	7	32 38 44 34 24 32 36
40	8	34 40 46 34 34 30 32 38
42	8	36 58 54 56 34 44 42 40
44	8	46 46 42 52 44 42 56 40
46	7	42 44 54 44 44 40 44
48	6	48 42 54 54 52 58
50	6	56 56 50 54 56 58
52	5	52 52 38 58 52
54	4	50 52 52 64
56	3	46 54 62
58	2	68 56
60	2	58 60
62	1	56
64	1	60
66	1	68

$r = .82$

case of such individuals the injustices shown in this paper will of necessity result. In constructing an examination for any particular group in any particular subject, it is advisable to ask the question as to whether the true false form of examination, because of the scope or subtlety of the informational ability tested, or because of ease of construction, has sufficient merits to counterbalance the evil psychological statistical factors which are its necessary concomitants. With other forms of examination such as the single word answer or completion types the evils which accompany guessing do not enter.

MENTAL TESTS AS AN AID IN THE ANALYSIS OF MENTAL CONSTITUTION*

By Harry J. Baker
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It is the purpose of this investigation to discover to what extent a useful diagnosis of mental constitution can be effected by means of mental tests, as carried on under such conditions as might be found in psychological clinics. We are now quite warranted in assuming that mental tests are the most reliable means available for the measurement of general mental ability, but there have been few attempts made to employ mental tests extensively for the examination of the details of mental equipment. Periodical literature on psychological testing shows that two methods have been followed: (1) a limited number of tests of special abilities, such as "Logical Memory," "Range of Apprehension," etc., has been used; (2) general intelligence tests have been applied to large numbers of individuals by the group method.

Although many of the mental tests used in this study are adapted to the group method of application, yet at much expenditure of time nearly all of the tests were actually administered by the individual method. The individual method affords an excellent opportunity for personal observation upon the part of the examiner, particularly with respect to the nature of the reaction. An acquaintanceship more or less intimate was cultivated with each subject in order that a full knowledge might be gained of his family conditions, early training, ideals, interests and ambitions. The available school records were examined and a summary of the most important anamnesic data has been incorporated in the analysis of each subject's test record.

The Subjects Of The Experiment

Fifty subjects were selected for this study. Twenty-five of them were pupils either from the Ann Arbor High School or from the Central Eighth Grade in Ann Arbor. The other twenty-five were students from the University of Michigan. Two of the latter group were from the Engineering College, the remainder from the College of Literature, Science, and the Arts. By chance there were fifteen boys and ten girls in each group of subjects. The High School subjects were selected by the principal and the teachers

*Condensation of a dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the University of Michigan. Prepared under the direction of Dr. Guy Montrose Whipple, Professor of Experimental Education.

who are in charge of the session rooms. The college subjects were selected by three methods: (1) volunteers who heard of the nature and purpose of the study; (2) those recommended by instructors or fellow-students; (3) those selected entirely upon the basis of their college records.

The High School Subjects

There are three session rooms in the Ann Arbor High School, with one teacher in charge of each room. Each of these teachers selected a group of about ten pupils and submitted rankings of her own group on the basis of scholastic ability. All of these pupils were then given the "Thurstone Intelligence" test in a group. The rank correlation between the scores in the Thurstone test and scholastic ability was moderately high in each group, with a high correspondence at the two extremes of superior and inferior ability. The principal next selected from these groups those pupils whom he considered most desirable subjects from our point of view. Three pupils of superior scholastic ability, one from each session room, were included as a general check upon the study. Twenty subjects were taken from these groups and five were added from the Central Eighth Grade. These last pupils were nearly all repeaters in that grade and were very poor in scholarship. As this grade is quartered in the high-school building and as some of these subjects were partially cross-classified in the high school, it has been deemed expedient to designate them all as high-school subjects.

The Ages of High School Subjects

The distribution of these twenty-five subjects by age, sex, and grade is shown in Table I. From a study of this table it is evident that a few of these pupils are retarded one or more years, and that two or three others are somewhat accelerated in their school progress.

TABLE I

THE AGE-SEX-GRADE DISTRIBUTION OF THE HIGH SCHOOL SUBJECTS.

Grade	8th.		Fr.		So.		Jr.		Sr.		Total		Total
Sex	B.	G.	B.	G.	B.	G.	B.	G.	B.	G.	B.	G.	Both
20					1				1		2		2
19								1		1		2	2
18									1	3	1	3	4
Age 17	1		2	1							3	1	4
16	1			1		1	1	1			2	3	5
15	2		1			1					3	1	4
14			2		1						3		3
13	1										1		1
Totals	5		5	2	2	2	1	2	2	4	15	10	25

Note—Age 20 includes from 19-6 to 20-5 inclusive, etc.

Average Scholastic Records of the High School Subjects

The average scholastic records of the high-school subjects are shown in Table II. The marking system in the Ann Arbor High School is on the basis of ten points, with no finer division than half points. The passing mark is 7.5. In order to secure the data for this table, school grades have been converted to a basis of one hundred points and the average of marks has been found for each individual. In the case of the high-school subjects all grades, including failures, made in their studies beyond the eighth grade were included in the average. Although average grades below the passing standard may be somewhat misleading in judging the progress of particular students, yet the exclusion of such grades would not present the real facts about the general ability of any subject. The school records for the eighth-grade subjects were limited to the preceding two semesters. The records were limited in this way in order that the subject matter represented might be as similar as possible to that of the high-school subjects.

TABLE II

AVERAGE SCHOLASTIC RECORD OF HIGH-SCHOOL SUBJECTS

	Grade	8th		Fr.		So.		Jr.		Sr.		Total		Total
	Sex	B.	G.	B.	G.	B.	G.	B.	G.	B.	G.	B.	G.	Both
	94-90					1	1				1	1	2	3
	89-85			1								1		1
Average	84-80								1	1	2	1	3	4
Scholastic	79-75									1		1		1
Record	74-70	2		2		1		1	1		1	6	2	8
	69-65	1		2	1							3	1	4
	64-60				1		1						2	2
	59-55	2										2		2
	Totals	5		5	2	2	2	1	2	2	4	15	10	25

The College Subjects

In selecting college subjects a larger field of choice was opened than with the high-school subjects. Through the kindness of University officials free access was given to the college records of all students in the College of Literature, Science, and the Arts. Eventually the list of twenty-five subjects was constituted as follows: (1) seven volunteered upon hearing what was the nature and purpose of the study; (2) four were secured through reports from others, or by mere chance; (3) fourteen were selected upon the basis of their college records. All tests were administered by the individual method.

The Ages of the College Subjects

The distribution of the college subjects by age, sex, and college class is shown in Table III. There are but a few reliable inferences

to be drawn about retardation from this table, since those whose records are the worst in this respect have either been out of college in other occupations or were called to war.

TABLE III

THE AGE-SEX-CLASS DISTRIBUTION OF COLLEGE SUBJECTS.

	Class	Fr.		So.		Jr.		Sr.		Total		Total
	Sex	M.	W.	M.	W.	M.	W.	M.	W.	M.	W.	Both
Age	28							1		1		1
	27											
	26					1		1		2		2
	25											
	24								1		1	1
	23					1	1	1	1	2	2	4
	22	3		2	1			1		6	1	7
	21				1		1				2	2
	20		1	1			2			1	3	4
	19	1			1					1	1	2
	18	2								2		2
Totals		6	1	3	3	2	4	4	2	15	10	25

THE VARIETY OF COLLEGE RECORDS

There is more significant scattering of grades in the college subjects than among the high-school subjects. This scattering is probably due to a wider field of electives and to a less intimate general knowledge of students upon the part of teachers. College markings are by letters; A, very superior; B, superior; C, average; D, passing but without honor points applying for graduation; and E, complete failure. It might well be explained that for graduation not only are one hundred and twenty hours necessary, but also an average grade of at least C (100 on our scale). In Table IV the grades received by these twenty-five subjects are shown. This table is designed solely to indicate the amount of scattering of grades.

TABLE IV

THE GRADES OF COLLEGE SUBJECTS.

	Class	Fr.		So.		Jr.		Sr.		Total		Total
	Sex	M.	W.	M.	W.	M.	W.	M.	W.	M.	W.	Both
Grades	A C	1								1		1
	A B C							1	1	1	1	2
	A B C D						2		1		3	3
	A B C D E						2	1		1	2	3
	A C D E			1	1	1		1		3	1	4
	B C D			1	2			1		2	2	4
	B D E	1								1		1
	C D E	2	1			1				3	1	4
	C D	2								2		2
	C			1						1		1
	Totals	6	1	3	3	2	4	4	2	15	10	25

Average College Records

Table IV does not give specific information about the average standing of more than a few of the subjects. Since it seems desirable to have one quantitative record of each subject's college records, a somewhat arbitrary scheme was devised. This scheme was based on the system of honor points for grades of different degrees of excellence. The plan in use allows honor points as follows: A, three points per each hour's credit; B, two points for each hour's credit; C, one point for each hour; D, credit allowed but no honor points granted; E, no credit and no point. Each subject's hours and points were totalled and the raito found between them. Those ratios were next multiplied by 100 and the resulting products are the arbitrary averages shown in Table V. The possible range of these values is from 0, or all D's, to 300, or all A's. An average of C is represented by a grade of 100, while B is 200. This plan has the advantage of showing the fractional parts of corresponding letter values.

TABLE V

AVERAGE COLLEGE RECORD OF COLLEGE SUBJECTS.

	Class	Fr.		So.		Jr.		Sr.		Total		Total
	Sex	M.	W.	M.	W.	M.	W.	M.	W.	M.	W.	Both
Average College Record	299-251 (high B)							1		1		1
	250-200 (low B)											
	199-150 (high C)					1		1		2		2
	149-100 (low C)	2		3		2	2			7	2	9
	99- 50 (high D)	2			3	2	1	2		6	4	10
	49- 0 (low D)	2	1							2	1	3
	Totals	6	1	3	3	2	4	4	2	15	10	25

THE MENTAL TESTS AND THEIR ADMINISTRATION

The tests were administered at almost any time of day when appointments could be made. This was necessary in order to avoid conflict with the daily schedules of the student. Save for a few instances no two subjects were tested at the same time and then always with tests suitable for group work. All the testing was done in a quiet laboratory.

ORDER OF PROCEDURE

Although no hard and fast program of testing was followed, the order of administration was kept as uniform as possible. Six to eight hours were required for each individual, usually there were four sittings of about two hours each for each person.

The general order of tests was as follows:

First Sitting

1. Thurstone Intelligence test
2. Rote Memory for Digits
3. Stanford-Binet Examination
4. Cancellation test

Second Sitting

1. Army Alpha test
2. Visual Apprehension of Objects (two cards)
3. Two lists of Opposites
4. Visual Apprehension (tachistoscope)
5. Reading forward and backward
6. Logical Memory (Marble Statue)
7. Free Association (written)
8. Completion (Dr. Goldsmith's Medicine)

Third Sitting

1. Rote Memory, Words (concrete and abstract)
2. Range of Interest
3. Reading (Kelly)
4. Aussage (Australians)
5. Logical Memory (Dutch Homestead)
6. Word-building (*a e o b m t*)
7. Free Association (oral)
8. Completion (The Strength of the Eagle)
9. Linguistic Invention
10. Mirror-drawing

Fourth Sitting

1. Logical Memory (Dutch Homestead, delayed recall)
2. Word Building (*e a i r l p*)
3. Aussage (Disputed Case)
4. Substitution test

It will be noted wherever two tests of a similar nature were given, trials were allowed, when possible, on succeeding days; and that the program was varied as much as possible to avoid fatigue or ennui. The "Mirror-drawing" test was placed at the end of a day's program of testing, since it aroused emotional disturbances in some subjects.

This large number of tests, 26 in all, was used because it was our purpose to make an analysis of the mental constitution by their use. The list includes tests of general ability and of special abilities. Little comment is needed on the various tests. Army Alpha and Stanford-Binet were given and scored in the usual

way. The Thurstone Intelligence test (his "Test IV") is the first form of a so-called omnibus test containing 168 problems borrowed from the five forms of Army Alpha, and is given in a time limit of thirty minutes. The Range of Interest test which was borrowed from a special set devised and used by the Bureau of Salesmanship Research, of the Carnegie Institute of Technology, consists of one hundred statements, equally divided between right and wrong, and covers a wide field of topics. The Opposites test, Free association (written), comletion (Dr. Goldsmith's Medicine), Rote Memory for words (concrete and abstract), and the Substitution test were adapted from Pyle[1]. Kelly's Silent Reading test was employed. The remainder of the tests were taken from Whipple's Manual[2].

The Opposites tests were rather easy for college subjects, as was also the Completion test (Dr. Goldsmith's Medicine), although the time limit of the latter was reduced to five minutes. The Substitution test was of the digit-letter type with nine symbols. Five work-periods of five minutes each were allowed, with rest intervals of two or three minutes. In the Linguistic Invention test the story was built up around the ten words: *thief, landlord, crab, shake, hotel, basket, cries, provisions, escape,* and *custody,* and was graded by reference to the Thorndike extension of the Hillegas Composition scale. Unless otherwise specified, all scores appearing on profiles were composites of the two or more tests employed.

The Correlation of the Mental Tests

Although this study is not primarily statistical, the correlations of the various mental tests and school standings have been computed by the Pearson "Product-moment" method[3]. The chief value of correlation here lies in evaluating specific tests with respect to the other tests. Included among the items correlated is a composite score of all mental tests as well as a composite score of all scholastic standards available. The writer realizes fully that owing to the irregular weighting of mental test scores and the varying records of scholarship available, these two composite scores were of questionable value, but they are included with these precautionary remarks. The correlations of scores for high-school and for college subjects are shown in Table VI and VII, respectively. In these tables and also in figures 1 to 4 inclusive, the twenty-six tests have been somewhat rearranged by grouping those of like

1W. H Pyle, *A Manual for the Mental and Physical Examination of School Children*, p. 19.
2G. M. Whipple. *A Manual of Mental and Physical Tests.* Parts I and II.
3H. O. Rugg, *Statistical Methods Applied to Education*, pp. 274-276.

nature. The following is the grouping adapted: The Completion score is the total score of "Dr. Goldsmith's Medicine," and the "Strength of the Eagle;" the Opposites score includes both lists of Opposites; the Reading score includes Whipple's test of reading forward and reading backward, and Kelly's test of silent reading; both Oral and Written Free Association are included in Free Association; Word Building includes both groups of letters; in each Aussage test the score includes the written report, the deposition and the sworn deposition; Logical Memory includes the "Marble Statue" and the "Dutch Homestead," the latter of which has both immediate and delayed recall; Rote Memory for Digits includes the auditory and visual presentations; Rote Memory for Words includes both the concrete and abstract lists; the number of correct substitutions in the last five-minute period; in Mirror Drawing the score represents the sixth or last trial; Cancellation includes the *a-t* words and the *q-r-s-t* tests.

Analysis of the Bulk Results

The mental test results of all subjects are discussed as percentile scores. This plan is very easily comprehended and is more effective than giving merely the deviations of scores from the average. At present there is a woeful lack of usable standards fro mental tests. Many studies have been reported, but in almost all instances the numerical results are limited to the average, or to the average and the standard deviation. After examining many other experiments the writer was forced to make percentile tables from his own limited number of cases. Owing to the different abilities of the various subjects however, it is believed that these percentile values are at least a rough approximation to a wider sampling. These percentile scores of the high-school and of the college subjects are shown in Tables VIII and IX respectively.

Case Studies of High School Subjects

The general reading public has little or no interest in these subjects as individuals and therefore, even though space might warrant, a discussion of all cases is not pertinent. A limited number of the more striking cases will be discussed, however, to illustrate the possibilities of the method.

The "Profile method" of Rossolimo[4] was felt to be suggestive as a device for showing the individual's mental test records at a glance. However, instead of showing these results on a scale of ten points as he did, it seemed better to show them on a basis of one hundred points, by means of percentiles, that is, by position

[4]G. Rossolimo, Die Psychologischen Profile. Zur Methodik der quantativen Untersuchung der psychischen Vergange in normalen und pathologischen Fallen. *Klinik f. psychische u. nervose Krankheiten*, 6, 1911 Heft 3.

TABLE VI Correlation of Scores of the Twenty-Five High-School Subjects

	Total of all mental tests	Army Intelligence	Thurstone Intelligence	Binet Mental Age	Binet Intelligence Quotient	Completion	Opposites	Reading	Range of Interest	Free Association	Linguistic Invention	Word Building	Visual Apprehension (Tachis.)	Visual Apprehension (Objects)	Aussage (Australians)	Aussage (Disputed Case)	Logical Memory	Rote Memory (Digits)	Rote Memory (Words)	Learning (Substitution)	Learning (Mirror Drawing)	Cancellation
Army Intelligence	.78																					
Thurstone Intelligence	.76	.81																				
Binet Mental Age	.83	.77	.71																			
Binet Intelligence Quotient	.68	.68	.61	.78																		
Completion	.60	.58	.61	.55	.48																	
Opposites	.81	.69	.59	.65	.52	.45																
Reading	.75	.73	.80	.64	.46	.52	.77															
Range of Interest	.47	.66	.56	.47	.55	.28	.28	.32														
Free Association	.75	.62	.60	.74	.65	.30	.71	.60	.32													
Linguistic Invention	.85	.55	.55	.67	.50	.40	.77	.71	.22	.62												
Word Building	.56	.40	.32	.59	.49	.53	.51	.42	.28	.45	.62											
Visual Apprehension (Tachis.)	.61	.62	.45	.47	.04	.39	.63	.53	.23	.53	.58	.36										
Visual Apprehension (Objects)	.38	-.08	-.01	-.28	-.17	.18	.35	.07	-.09	.04	.21	.18	-.10									
Aussage (Australians)	.63	.35	.49	.56	.60	.45	.47	.42	.39	.40	.47	.49	.16	.24								
Aussage (Disputed Case)	.66	.37	.21	.62	.59	.65	.40	.19	.20	.42	.46	.65	.42	.06	.47							
Logical Memory	.70	.59	.38	.68	.59	.29	.56	.40	.50	.48	.61	.75	.58	.14	.54	.51						
Rote Memory (Digits)	.51	.56	.37	.41	.67	.33	.43	.28	.30	.48	.31	.23	.57	.13	.19	.31	.47					
Rote Memory (Words)	.45	.55	.38	.44	.45	.31	.56	.37	.46	.33	.35	.28	.55	.22	.30	.26	.78	.52				
Learning (Substitution)	.58	.22	.29	.22	.08	.55	.42	.29	.08	.21	.30	.41	.28	.54	.29	.29	.28	.25	.29			
Learning (Mirror Drawing)	.52	.23	.39	.26	.08	.22	.47	.52	.00	.46	.63	.18	.16	.18	.28	.18	.26	-.02	-.06	.24		
Cancellation	.53	.14	.16	.22	.06	.45	.57	.33	-.06	.23	.36	.34	.23	.81	.32	.38	.25	.12	.25	.72	.37	
Average	.64	.51	.48	.53	.45	.43	.55	.49	.31	.47	.51	.43	.39	.15	.41	.40	.49	.35	.38	.32	.26	.32
Scholarship	.78	.67	.67	.63	.63	.53	.69	.65	.49	.66	.61	.42	.56	.13	.55	.34	.48	.62	.58	.52	.25	.36

Note.—When N is 25,
for value of r from 0 to .13 P.E.=r
for value of r from .14 to .25 P.E.=r/2
for value of r from .26 to .35 P.E.=r/3
for value of r from .36 to .43 P.E.=r/4
for value of r from .44 to .52 P.E.=r/5
for value of r from .53 to .56 P.E.=r/6
for value of r from .57 to .60 P.E.=r/7

TABLE VII Correlations of Scores of the Twenty-Five College Subjects

	Total of all mental tests	Army Intelligence	Thurstone Intelligence	Binet Mental Age	Binet Intelligence Quotient	Completion	Opposites	Reading	Range of Interest	Free Association	Linguistic Invention	Word Building	Visual Apprehension (Tachis.)	Visual Apprehension (Objects)	Aussage (Australians)	Aussage (Disputed Case)	Logical Memory	Rote Memory (Digits)	Rote Memory (Words)	Learning (Substitution)	Learning (Mirror Drawing)	Cancellation
Army Intelligence	.75																					
Thurstone Intelligence	.90	.59																				
Binet Mental Age	.58	.47	.45																			
Binet Intelligence Quotient	.83	.54	.44	.97																		
Completion	.92	.70	.56	.55	.80																	
Opposites	.37	.15	.23	.12	.17	.32																
Reading	.84	.81	.63	.61	.66	.79	.34															
Range of Interest	.38	.20	.27	.28	.34	.42	.08	.47														
Free Association	.68	.27	.45	.21	.24	.14	.29	.27	.09													
Linguistic Invention	.71	.41	.40	.59	.58	.54	.39	.38	.43	.34												
Word Building	.55	.33	.45	.48	.51	.39	-.02	.35	.21	.39	.35											
Visual Apprehension (Tachis.)	.79	.20	.25	.66	.65	.55	.18	.47	.11	.20	.44	.17										
Visual Apprehension (Objects)	.25	-.05	.59	.12	.12	-.10	-.09	.19	-.08	.26	-.06	-.11	.58									
Aussage (Australians)	.67	.43	.25	.19	.19	.36	.14	.36	.47	.35	.33	.12	.49	.30								
Aussage (Disputed Case)	.55	.08	.23	.30	.26	.41	-.16	.25	.12	.09	.13	.07	.30	-.02	.54							
Logical Memory	.94	.26	.49	.47	.48	.54	.26	.41	.04	.44	.40	.12	.63	.26	.51	.62						
Rote Memory (Digits)	.38	.00	-.03	.55	.52	.29	.12	.24	-.06	.08	.32	.11	.76	.63	.21	-.04	.28					
Rote Memory (Words)	.28	.19	.04	.50	.47	.18	.12	.13	-.41	.10	.25	.13	.51	.35	.01	-.02	.31	.63				
Learning (Substitution)	.81	.31	.46	.45	.45	.49	.12	.49	.05	.22	.31	.17	.78	.53	.40	.36	.69	.56	.37			
Learning (Mirror Drawing)	.52	.02	.21	.27	.27	.26	.18	.10	.03	-.20	.29	.21	.14	.44	.13	.09	.06	.54	.32	.46	.11	
Cancellation	.54	.09	.41	.18	.22	.27	.22	.25	.22	.29	.18	.16	.24	.07	.15	.14	.27	.02	-.05	.32	.02	.20
Average	.63	.30	.39	.43	.46	.44	.16	.43	.16	.27	.36	.24	.42	.18	.31	.20	.43	.28	.20	.40	.20	.20
Scholarship	.64	.54	.61	.40	.41	.52	.34	.63	.56	.38	.36	.23	.13	-.07	.31	.28	.39	-.13	-.14	.07	-.03	.47

Note.—When N is 25,
for value of r from 0 to .13 P.E.=r for value of r from .36 to .43 P.E.=r/4
for value of r from .14 to .25 P.E.=r/2 for value of r from .44 to .52 P.E.=r/5
for value of r from .26 to .35 P.E.=r/3 for value of r from .53 to .56 P.E.=r/6

TABLE VIII Percentile Scores of the Twenty-Five High-School Subjects

Tests	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Army Intelligence	80	66	20	60	30	99	40	30	8	50	40	48	28	15	80	70	30	55	88	18	77	93	70	29	1
Thurstone Intelligence	80	60	52	65	35	99	40	20	24	12	45	32	8	26	80	80	88	65	88	18	57	90	90	45	1
Binet Mental Age	90	60	48	45	4	94	45	52	30	70	55	28	19	17	70	40	87	70	60	26	99	90	70	18	1
Binet I. Q.	98	57	80	74	9	60	30	40	24	80	45	20	13	12	60	30	70	60	54	40	99	93	60	25	1
Completion	99	9	29	45	60	84	79	22	20	53	72	40	65	12	30	58	93	67	95	13	80	40	86	48	1
Opposites	73	65	30	30	54	89	10	40	1	20	60	60	30	7	82	71	40	92	58	10	96	80	99	40	40
Reading	60	40	45	67	81	99	30	25	1	25	36	20	15	45	88	78	55	91	70	18	66	80	94	52	4
Range of Interest	92	85	80	68	4	99	60	84	40	48	65	30	30	15	48	93	20	30	70	1	50	80	50	18	30
Free Association	92	82	39	13	26	80	55	43	20	60	16	8	1	28	96	68	65	99	40	45	89	75	72	60	33
Linguistic Invention	80	60	80	40	80	88	60	52	5	25	18	25	40	25	88	60	65	99	35	1	99	40	92	15	25
Word Building	83	64	60	40	45	90	70	40	1	86	25	30	16	60	20	14	70	60	80	5	99	30	95	20	66
Visual App. (Tachis.)	90	90	30	17	50	50	20	30	1	20	30	20	80	70	20	80	40	60	40	20	99	70	90	60	7
Visual App. (Objects)	35	35	8	35	55	55	70	70	85	55	85	55	55	85	15	70	25	99	15	5	85	15	99	15	55
Aussage (Australians)	99	7	70	55	10	94	30	80	64	44	70	50	1	47	33	10	80	84	60	20	75	40	92	20	19
Aussage (Disputed Case)	85	15	55	1	20	80	60	82	20	93	40	43	47	8	20	60	94	65	77	10	99	30	70	54	30
Logical Memory	90	91	72	20	49	91	50	80	50	19	32	64	40	30	60	18	55	35	45	1	99	75	82	25	3
Rote Memory (Digits)	90	75	40	40	5	75	75	5	20	40	90	40	75	75	90	40	40	40	40	40	99	90	40	40	5
Rote Memory (Words)	80	93	15	65	30	97	40	65	30	15	80	50	80	5	15	30	40	65	50	1	99	90	55	65	15
Learning (Substitution)	64	13	8	54	20	79	99	55	72	1	60	40	88	28	36	62	68	86	28	45	92	32	92	49	17
Learning (Mirror Drawing)	60	20	60	20	72	91	50	60	60	25	1	78	40	35	99	83	92	87	1	15	55	40	80	30	45
Cancellation	12	30	1	26	18	80	87	73	66	48	86	65	66	58	40	66	77	94	40	30	92	8	99	20	33
Average	78	53	44	42	36	84	61	50	31	42	50	40	39	33	57	56	62	78	54	18	86	61	80	36	21

TABLE IX PERCENTILE SCORES OF THE TWENTY-FIVE COLLEGE SUBJECTS

Tests	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Army Intelligence	40	27	1	15	60	40	94	62	99	20	80	68	5	46	17	85	30	60	72	28	34	50	80	93	72
Thurstone Intelligence	35	40	7	17	35	45	95	55	99	26	77	5	62	80	1	80	60	60	83	92	76	22	45	30	52
Binet Mental Age	60	70	1	10	30	40	80	40	99	8	20	80	80	90	35	99	34	90	70	55	30	60	15	55	60
Binet I. Q.	60	75	1	15	30	45	80	55	99	10	20	80	80	90	40	99	34	90	70	59	20	60	15	86	60
Completion	50	65	4	14	1	35	99	20	99	12	40	54	40	45	28	84	25	90	70	80	50	75	35	90	76
Opposites	1	15	70	40	25	75	95	1	99	40	17	13	65	80	80	48	34	60	35	85	60	85	65	55	35
Reading	60	56	32	15	8	17	92	20	99	1	55	72	42	74	25	85	20	45	85	80	40	33	70	93	78
Range of Interest	28	16	20	1	60	50	95	80	99	80	50	70	10	25	77	80	40	50	36	30	70	50	8	95	70
Free Association	15	60	1	65	9	34	68	80	99	46	48	50	93	88	77	55	99	20	24	40	72	28	90	32	16
Linguistic Invention	40	60	8	1	4	48	80	60	95	17	20	48	35	99	94	80	12	70	35	53	80	80	66	20	70
Word Building	40	77	1	8	30	15	80	25	60	60	40	65	85	92	20	99	92	36	50	50	70	16	90	70	30
Visual App. (Tachis.)	65	50	30	30	1	25	28	65	96	1	3	65	80	50	80	80	20	99	65	80	50	20	40	55	90
Visual App. (Objects)	55	75	70	75	15	30	10	90	99	30	30	55	90	30	80	55	10	30	30	30	30	1	55	55	90
Aussage (Australians)	56	40	40	53	9	10	80	96	99	65	20	60	1	15	87	92	26	80	30	65	88	25	72	45	55
Aussage (Disputed Case)	85	80	34	60	1	18	92	99	60	10	40	60	20	23	35	55	50	92	70	72	88	46	25	47	14
Logical Memory	30	85	19	32	1	60	70	92	99	12	20	50	68	57	40	50	20	95	85	80	72	40	68	30	8
Rote Memory (Digits)	70	55	55	40	30	30	20	55	90	16	20	55	90	55	90	90	15	90	40	55	1	40	55	40	90
Rote Memory (Words)	90	90	35	70	20	40	40	30	40	20	10	55	99	75	70	55	15	55	36	75	10	30	55	1	55
Learning (Substitution)	55	68	42	45	12	40	8	75	99	1	20	27	60	35	20	80	32	85	60	92	72	28	80	62	89
Learning (Mirror Drawing)	48	20	1	50	7	83	60	60	75	25	30	54	86	60	80	50	60	99	96	12	30	25	99	10	40
Cancellation	23	72	15	12	77	35	67	46	84	20	60	9	99	1	82	80	58	45	60	95	93	40	35	65	10
Average	48	57	23	32	22	39	68	57	90	25	34	52	61	58	55	75	37	69	57	62	54	41	55	54	55

among a hundred persons instead of by actual score. The test scores of the subjects, who are discussed in detail, are shown graphically in Figures I to IV inclusive. The base line of the probability curve of frequency distribution for which the percentile values are known, made a suitable scale for graphic representation.

The fact that the differences in score between the fiftieth and sixtieth percentile is less than between the ninetieth and one-hundreth percentile is made obvious by this method.

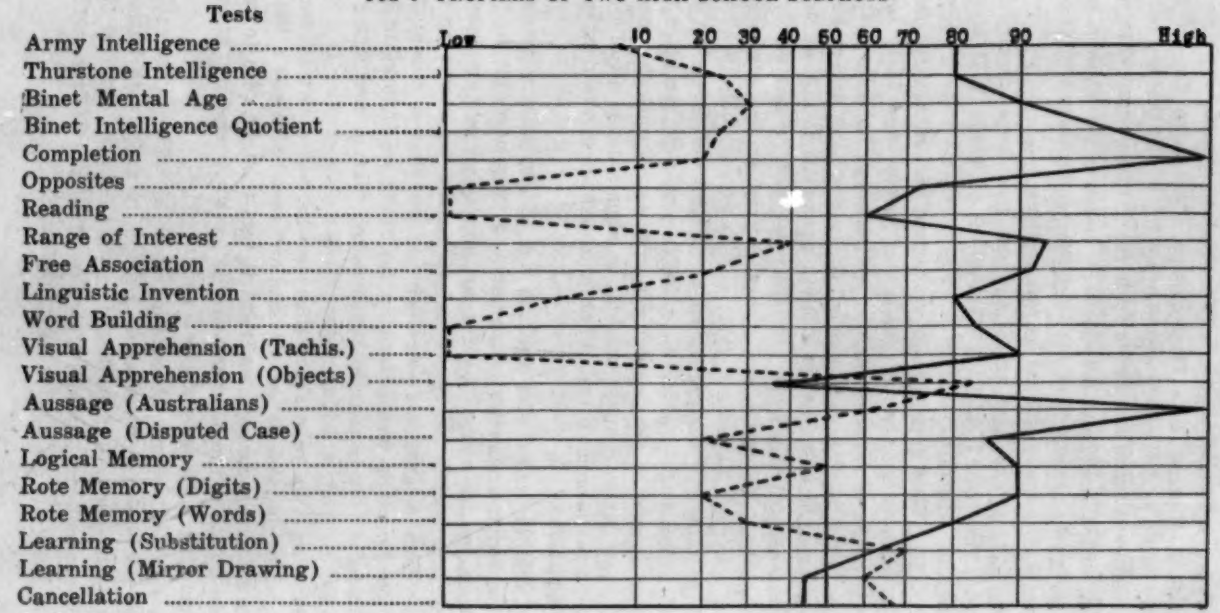
Four cases from the High-school subjects have been selected for discussion. They are Nos. 1, 9, 13, and 19 of Table VIII in the column headed "Tests."

Case No. 1. (Very superior and consistent mental ability) Boy; age 14:4; sophomore; average grade 92; mental age 18-1; I. Q. 127. He is a boy of superior ability, and although he is more than two years below the average age of the group with whom he is being compared, he is above the fiftieth percentile in all but three mental tests—three which do not show a *good* correlation with general ability. He made the highest record in the completion tests and the first "Aussage" test, and is in the vicinity of the eightieth or ninetieth percentiles in almost all of the tests. His army test score is 145, which is above the average score for the sophomores in one of the largest universities. Although he was urged to exert himself on these tests, he seemed to do all of them with ease, and showed no emotional disturbances in the most perplexing situations.

He is slightly under size for his age, dark, with a pleasing though somewhat sophisticated manner. It was difficult to find time to complete the mental tests on account of his many activities. He is carrying such a heavy schedule of school work that he has only three periods available per week for studying at school. Yet after school hours he was practicing for track, so that he had to prepare most of his lessons in the evening. He is also active in the Boy Scouts and is taking piano lessons. His mother is a talented musician. Up to a short time ago he had delivered newspapers, and in the oral "Free Association" test he named a list of city streets at an amazing rate, until it was thought wise to suggest some different topic, whereupon he gave a longer list of articles of clothing with even greater speed.

It was very evident that his relations with his parents are happy. His chief ambition, after finishing college, is to go into business with his father, who is a broker. One cannot help but feel that when his interests are thoroughly awakened he will achieve marked success in some one of the higher professions.

FIG 1 PROFILES OF TWO HIGH SCHOOL SUBJECTS



This boy's school record is excellent and his teachers rate him very high. He carries his heavy schedule with ease. He is going through the high school as rapidly as possible and expects to enter college immediately thereafter. Exceptional ability linked with great industry and variety of interests, make a fortunate combination in this lad which should guarantee his success.

Case No. 9. (Inferior mental ability.) Boy; age 16-7; eighth grade; average grade 56; mental age 15-0; I. Q. 94.

There are certain striking constitutional differences in this boy's case which are not disclosed in tests given by the group method. His specific abilities are on a slightly better level than his general ability, but even in those he has peculiar records. The low record in "Reading" and "Visual Apprehension" is of most significance. Apparently he has a mild form of aphasia, since his visual apprehension of non-verbal material was nearly normal, but that for verbal material was very low. Tests involving rapid rates of reading uniformly brought low records. He wears glasses which give normal vision.

He is said to have some ability in drawing, and during the past semester he earned a grade of 8.5 in mechanical drawing. This boy attended school in Detroit for several years, where he repeated the work of the fifth grade. Since then he has always had difficulty in earning promotion. He failed in the eighth grade last year, but on account of his age and size, (he is tall and fully developed physicially) he was advanced to the high school on trial. He was unable to carry the work there and was removed to the eighth grade, where he failed again in the traditional subjects.

He claims that he failed in school on account of general ill health, and also that he has a weak heart. He comes from an average family. An older sister is completing her university course this year. He is not seriously concerned about his poor progress or about his handicap in reading. Although he was urged to have a special tutor in reading, to our knowledge he has done nothing about it.

His example and presence in the classroom are very trying to his teachers; his handwriting, for instance, is practically illegible. He should be in a special room. Although he is beyond the legal school age, he shows no inclination to leave school or consider work. It is the lesser of the two evils to remain in school as long as possible. The school should do its best to fit him for a semi-skilled trade, where his ability for drawing would be utilized. At present his time and that of the teacher is practically wasted.

It was only by careful and somewhat extensive work with many mental tests that his difficulties were discovered. His mentality,

judged by a group test, would be rated low, and he would be relegated to a slow section upon a flexible plan of promotion. In his case the group method was not sufficient to determine the chief trouble.

Case No. 13. (Erratic and generally inferior mental ability.) Girl; age 17-3; freshman; average grade 67; mental age 14-3; I. Q. 89.

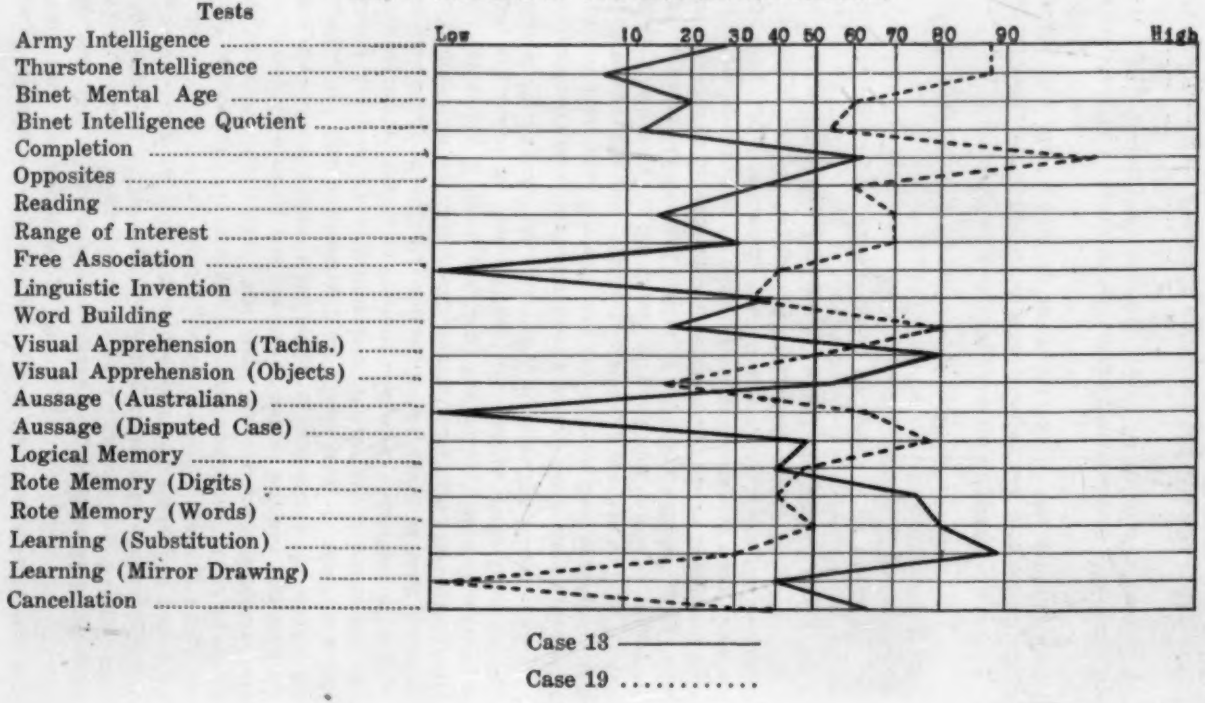
In general ability this girl is approximately at the twentieth percentile. On the average her specific abilities are somewhat better. She makes the lowest record in "Free Association," both written and oral. Her rate of association, which these tests are attempting to measure, is slow. The low record in the "Aussage" Australians is probably accidental, for instead of writing a complete description she merely made a brief list of items. Upon being urged to remedy this defect in the second test she made a record much better than in the first test.

School work of not more than passing grade is expected with such a record. She has earned passing grades in but two commercial subjects and has failed twice in bookkeeping. She realizes her limitations and is taking no more than enough commercial work to secure a position, but will probably fall short of attaining even that limited goal. Her own ill-health and that of her mother keep her out of school a great deal. While she does not have a very positive personality, she is reported to be quite vain about her appearance and spends valuable time in attempting to attract the attention of boys. These efforts are a flat failure. She will soon drop out of school, for she is deriving little benefit therefrom.

Case No. 19. (Variable mental ability.) Boy; age 16-10; freshman; average grade 71; mental age, 17-1; I. Q. 107.

Here is a striking case in which the general ability is average and the specific abilities fall to a much lower level. His highest score is in the "Completion" tests—above the ninetieth percentile. In "Visual Apprehension" he stands below the average, but in the "Aussage" tests, which also involve apprehension, he rises above the average. All his memory test records lie between the fortieth and fiftieth percentiles. His most anomalous record is in the "Mirror-drawing" test, in which his sixth trial record was the same as his first one, the second was even slower than the first, the third and fifth were the highest, and the fourth slightly lower. His efforts throughout this test were expended in trying to reason out what direction to go rather than proceed by trial and error as the instructions dictated. He was so determined on this policy that his record shows decided fluctuations. Being of a mechanical

FIG,. 2 PROFILES OF TWO HIGH SCHOOL SUBJECTS



turn of mind he seemed unable to resist the temptation which presented itself to experiment a little.

On the basis of the profile, especially of the general intelligence portion, we would expect him to be a fair student. Nevertheless, he has been one of the most perplexing cases with which the school has had to contend. The boy simply does not study, but spends all his spare time around laboratories, frequently getting numerous minor injuries by unsupervised experimentation. One finger is missing from his left hand, and other injuries are in evidence. He has passed in algebra and General Science, but has repeated his other high-school studies. He takes no interest in the traditional subjects, and spends practically all of his time on work of a mechanical nature. To expostulations about this unwarranted emphasis upon mechanics, he remains unmoved. Attempts to emphasize the fallacy of such an unprecedented waste of time made no impression upon him, although he admitted that he wanted to enter the Engineering College, and described many pieces of apparatus which are found in that college. He spends much time reading "Popular Mechanics," etc., and very little on his school work.

He comes from an inferior family where he is among the older of several children. His eyes are dreamy; his hair is almost white and is wavy. His test profile is strikingly similar to that of case No. 22. It is possibly the result of good ability linked with poor application and little devolopment of specific abilities. In his case unless he can be induced to realize the value of the traditional subjects it would seem well to allow him immediately to work along his natural bent as a major interest. In any event, it is a misfortune to drop such a boy from school, although his record is poor. There should be some way provided by which his ability and interest can be cultivated, for he might easily be successful as a mechanic or inventor. Society needs to conserve its talent in such cases which at least have good chances of success. We regret that our armamentarium of tests did not happen to comprise any that might have measured his mechanical aptitudes.

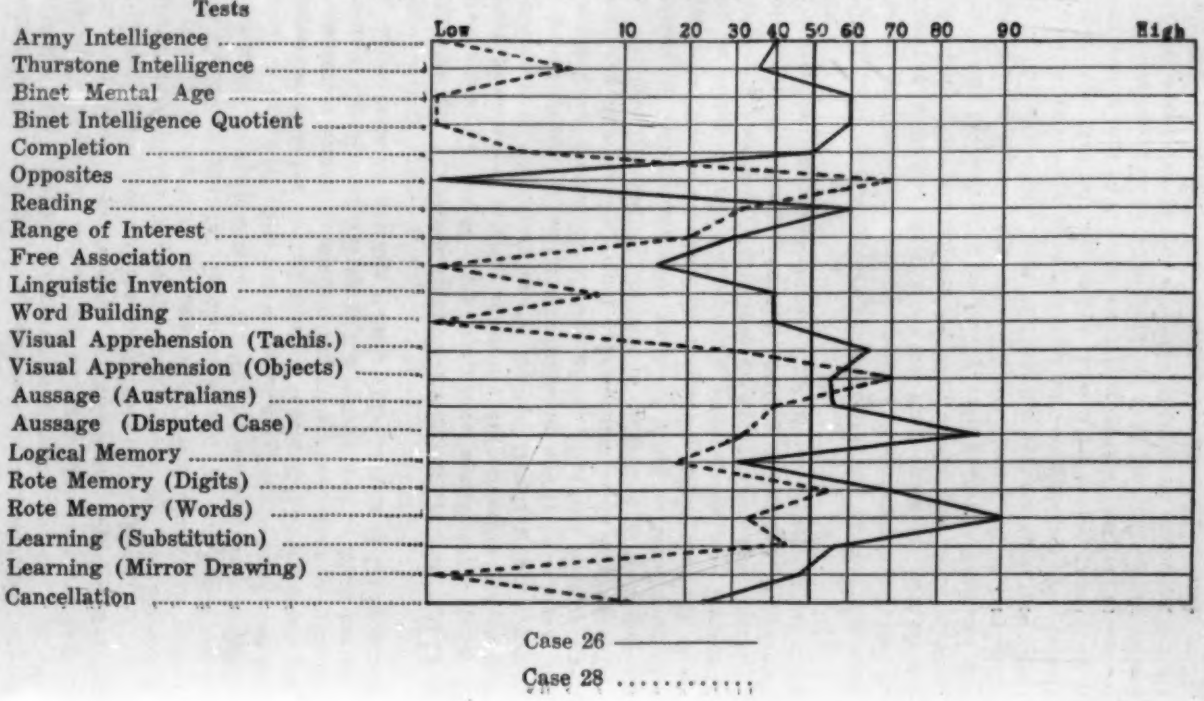
Case Studies of the College Subjects

Four college subjects have been selected for discussion. They are No. 26, 28, 43, and 49 of Table IX, in the column headed "Tests."

Case No. 26. (Average and erratic mentality.) Woman; age 18-1; college sophomore; average grade 84 (high D); mental age 18-1; I. Q. 113.

In mentality this woman is well above the average of the general population but not above the average of college students. Her

FIG. 8 PROFILES OF TWO COLLEGE SUBJECTS



greatest difficulties are with Associations, as measured by the "Opposites" tests (which are particularly poor), and by "Free Association." She is as low as the thirtieth percentile in "Logical Memory." None of her records is sufficiently superior to place her in the highest tenth of the individuals of this group.

Her college record is also of mediocre quality. She has one B and that is in rhetoric. In several different courses in various fields she has earned C's. In chemistry she has one D and one E.

She comes from an average family and has attended the public schools of this city. She has a vague ambition to teach, but has not yet selected her special field of teaching. Even though she should devote herself to study more industriously than is to be expected of a person of this type, she will do well to finish her college course with an average record. The outlook is for generally inferior college work.

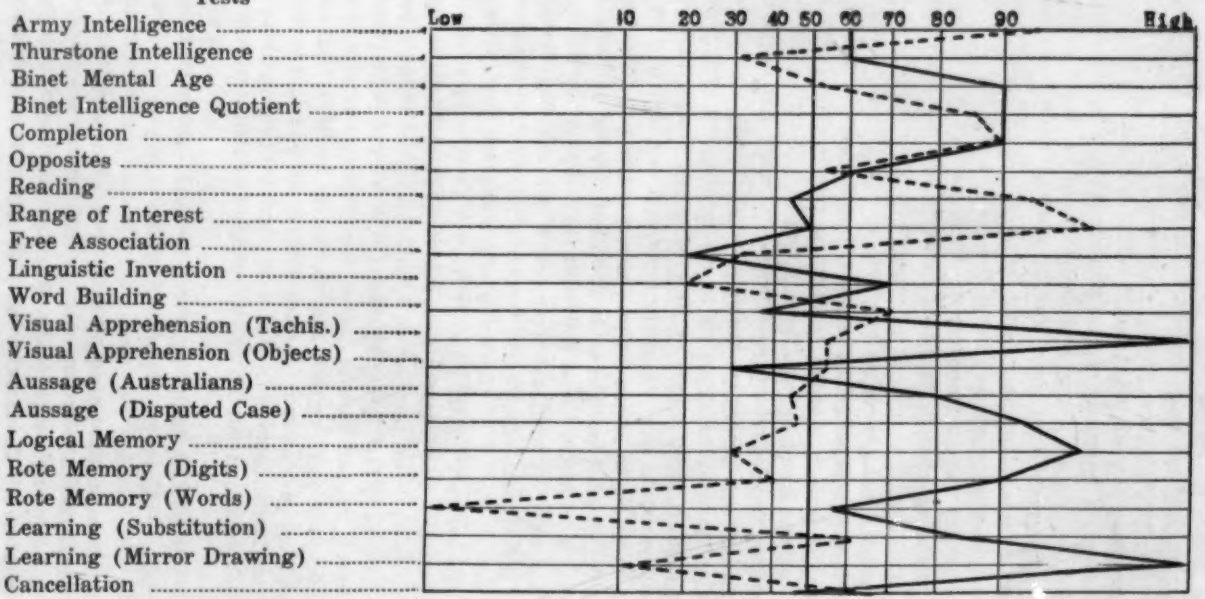
Case No. 28. (Consistently inferior mentality.) Man; age 23-4; junior; average grade 66 (high D); mental age 15-10; I. Q. 99.

Poor records and inferior mentality are obviously concomitant in this subject. His score in the "Army" test is only 100 points, our lowest record. In all tests of linguistic ability he is among the lowest five per cent of the college group. His best records are in those tests where quick visual apprehension is an important factor. His memory abilities are next in order of excellence, but are mediocre in comparison with those of other individuals in this group. In "Mirror-drawing" he insisted in trying out the directions in which to move his pencil, although he was frequently warned that success in this test depended upon the method of trial and error. His mental test records throughout are exceedingly poor: he reaches the lowest level of our college group in six tests.

As would be expected, his college records are of the same very inferior quality as his mental ability. He has been retained in college on probation ever since he first entered. His highest grades are C. He has failed signally in several courses in sciences.

He comes from an inferior family. His father is dead and this young man is forced to provide his own means. It is very difficult to be sympathetic with him for his personality is not pleasing; he is extremely strong-headed and opinionated. He expects to enter the Medical college but he will be barred from it by a recent ruling that no student will be accepted in that institution unless he has made an average grade of C in his preliminary college work. Granted that he was admitted, there is no doubt but that he would fail completely. Wise vocational guidance from early youth,

FIG.. 4 PROFILES OF TWO COLLEGE SUBJECTS



conducted in the light of facts concerning his mental ability, might well have saved him from his present humiliation, saved him from needless expenditure of time and money, and placed him in a less exacting field where he could have been successful with certain limitations.

Case No. 43. (Consistently superior mentality.) Woman; age 21-10; sophomore; average grade 70 (high D); mental age 19-0; I. Q. 119.

This young woman presents one of the most striking cases which are found in this study. There is a wide discrepancy between her mental ability and her college record. It is evident from her scores in mental tests, as shown on her profile, that she has superior mental ability. Two of her lowest records are in "Visual Apprehension" of objects and in "Cancellation." Her lowest record is in "Free Association," particularly in the oral test. In all but one of the memory tests she has superior records, and she makes excellent scores in both of the "Learning" tests. Her records warrant the belief that she has superior ability.

As a matter of fact, however, her college records are decidedly inferior. Her average grade is lower than C. The crux of her difficulty lies in a curious reticence which amounts to a downright reluctance to answer questions or to talk, at least under classroom conditions. In courses where oral recitation is the most important factor, she has the greatest difficulty. She prepares her lessons quite thoroughly, but is so slow in contributing to classroom discussion that she is passed over as being unprepared, or incapable of mastering the material at hand. Although she is proficient in presenting her ideas in writing, her incompetency in oral recitations more than offsets this proficiency. She now realizes what her chief difficulty is, and in order to improve herself in this respect she is taking oratory and is demanding special attention from her instructor. She declares that this defect did not produce difficulties in her high-school courses.

Although she has had one year's experience in school teaching she has been so completely disheartened at her failure in college that she has not formulated plans for the future, either to enter upon teaching or any other career. She appears to have fallen into a rut from which just now only the special drill in public speaking seems to promise any escape.

Case No. 49. (Average and erratic mentality.) Man; age 22-4; college sophomore; average grade 100 (low C); Mental age 18-1; I. Q. 113.

This man has a better record in tests of general intelligence than in tests of specific abilities. His low record in the "Thurstone

Intelligence" test is due to an erroneous idea that there were only 69 problems whereas there were actually 168. He did not hurry in this test until more than half of the time had elapsed, when he suddenly discovered the mistake. In the "Rote Memory" test for words, he became confused where the lists were long, and remembered fewer words than when the lists were somewhat shorter. He became extremely nervous while attempting the "Mirror-drawing" test.

His college record is average. He entered the University this year with advanced standing from a small college where his work had also been of average quality. He stated that he had some difficulty with high-school mathematics, but his "Analogies" test in the "Army" test showed very good performance.

He is an agreeable young man, and comes from a superior family. He intends to specialize in business administration. He was advised to reduce his rate of work and to seek accuracy, in which event he may become moderately successful.

His was a case in which the individual method of testing was exseptionally effective in detecting characteristic pecularities. He is a rapid worker but uncommonly inaccurate. It was noted, too, that his unwarranted speed of mental operations aggravates his nervous temperament. These conditions were brought to light fully by individual study.

Conclusions Concerning the Mental Tests

1. Tests specially designed to measure "general intelligence" are, of course, of paramount value in the measurement of all-round mental ability.

2. Tests of specific abilities, however, are essential for anything like an analysis of mental constitution.

3. In order that personal observation might be made, almost all of the mental tests were administered by the individual method, although many of them used in this investigation could well have been administered by the group method, and with a great saving of time. Here might be mentioned, for instance, the "Army Intelligence" tests, and the "Thurstone Intelligence" test.

4. The "Army Intelligence" test although designed for testing a different class of individuals, is nevertheless a very useful test for college and for high-school students. Its value lies chiefly in the splendid selection of material, and in the variety of tests which are included.

5. The "Thurstone Intelligence" test includes items of varying degrees of difficulty, and a penalty might well be imposed upon omissions.

6. The "Stanford-Binet" test is not sufficiently difficult to measure superior adult intelligence. In principle the test is very commendable.

7. The chief criticisms to be leveled at the "Completion" tests used in this investigation is that certain places in them are exceedingly difficult. Other forms now incorporated in various intelligence tests would probably have avoided this difficulty. In general, these tests correlate well with general ability.

8. "Opposites" tests have long been employed and with reliable results. In this study the "Opposites" were too easy for the college subjects, and not only should there have been more difficult terms, but also the number of items might well have been much increased.

9. The "Reading" tests are rightly included in this study, for reading is a common tool of the subject. Poor readers were easily detected by the special complicated text used in reading backwards.

10. The score in the "Range of Interest" test must be interpreted in its relation to maturity in the case of young pupils, but in the case of college subjects it is a direct index to general intelligence with little discount for maturity, save when it needs some discounting on account of unusually wide experience gained in travel or varied occupations.

11. Tests of "Free Association," both written and oral, are very commendable, in that fluency of verbal association is essential to success in them.

12 The "Linguistic Invention" test was of exceptional value in that it presented to all subjects a comparatively novel and interesting task. Ability to compose a short story is a fairly complex ability which taxes productive as well as mere reproductive capacity.

13. "Word-building" tests do not always work as satisfactorily as might be expected, because the more intelligent subjects may waste valuable time in forming useless letter combinations according to some logical plan.

14. The measurement of "Visual Apprehension" by the tachistoscope was generally satisfactory, although the two scores for college students were more consistent than for those for the high-school pupils. Since these tests showed a higher correlation with other tests for the college students than for the high school subjects, we may be led to conclude that they were too difficult for the latter group. Opportunity to handle non-verbal material was the chief value attaching to these tests.

15. Observation, perception and report were measured quite ef-

fectively by the "Aussage" tests. Although the two test scores were fairly consistent, the slight improvement in the second test was probably due to the practice derived from the first test. These qualities are of no little importance in the student's work.

16. Tests of "Logical Memory" have a slight correlation with general mentality, and are excellent in principle. Tests of "Rote Memory" are, in general, less significant than tests of "Logical Memory" and are useful chiefly for the diagnosis of a rather narrow special ability.

17. "Substitution" is valuable as a learning test if the subjects carry out the intent of the test. The results of this test become more reliable as progress is made from the first to the fifth trial —a point of some interest and one that has not always been observed by users of this type of test.

18. The "Mirror-drawing" test is not only a test of learning by trial and error, but it also is not infrequently an effective means of evoking charcteristic temperamental reactions upon the subject's part. Since this test involved a marked emotional element, it is not expected to have a high correlation with other "Learning" tests.

19. The "Cancellation" tests, to our knowledge have never afforded significant correlations with general mental efficiency. Attention might be called to the fact that their highest correlation with other specific tests was in the high-school records, 0.72 with "Substitution" and in the college records 0.32 with the same test. On the other hand, they correlated with the grand total of all mental tests 0.53 in the former and 0.54 in the latter group, respectively. The anomalous fact remains that "Cancellation" shows only low correlation with the "Army Intelligence" test in either group of subjects.

Other Conclusions

20. There is a dearth of reliable norms of mental tests. In order to satisfy requirements fully, percentile tables are most essential. A search through a wide field of literature on mental testing revealed practicaly no mental test scores which were comparable for our investigation.

21. It is evident from a study of the mental test profiles, and also from the correlation tables that the mentality of a given individual is, on the whole, a uniform affair. That is, high, comparatively average, or low efficiency in any test performance tends to be accompanied by a corresponding grade of efficiency in other performances. This conclusion is obviously quite at variance with the older theory of 'Compensation; and likewise with the prevailing popular notions about the distribution of mental abilities,

though it does accord with the results usually obtained in the laboratory.

22. Many of the seemingly exceptional deviations from this tendency toward a general level ability that appear in certain profiles are to be explained by the operation of disturbing factors, e. g., by a sudden lag of interest, by a misinterpretation of instructions, or by inadequate appreciation of the technique involved.

23. Adaptability is one of the chief assets of superior intelligence. Lack of adaptability is very noticeable among inferior subjects, who were ill at ease in many of the tests involving unfamiliar situations.

24. On all the profiles there is a close correspondence in the scores obtained in the first four tests. The chief exception to this generalization lies in the low records sometimes made by good subjects in the "Thurstone Intelligence" test—records which as already noted, were usually due to a too slow rate of working.

25. Superior intelligence is not an absolute guarantee of excellent scholarship. Lack of interest in subject matter, in some instances lack of industry, or in other instances preference for other activities may contribute to mediocre scholarship.

26. Inferior intelligence is almost universally accompanied by inferior scholarship. By means of untiring industry, inferior intellects may here and there earn average records. But at best their returns are meagre for the energy expended.

27. Average intelligence, we would expect to find accompanied by average scholarship. As a matter of fact, we find it associated with all degrees of scholarship. In these cases, interest and industry become particularly important factors in determining scholarship.

28. Although definite life ambitions were rather clearly revealed in all the subjects examined, it is probably true that the most effective driving motive behind success in school is the ambition to earn a good mark in each course of study pursued.

29. Although home conditions and early training have but negligible influence on mentality, they are essential for the furtherance of ideals and ambitions. In general, better home conditions and better early training tend to be found oftener in pupils of better intelligence. While personality and good character are not necessarily concommitants of superior intelligence, they exert unwarranted influence upon the teachers' estimates of the mental ability of pupils, for instance, a pleasing manner coupled with ready speech and an appearance of really trying, no doubt do frequently mislead teachers with regard to certain inferior pupils.

30. There is a woeful lack of mutual understanding between college students and college instructors. The minor blame for this

difficulty lies with the instructors, who are unable to cope with personal problems of individual students on account of the large number of students under their direction. The major blame rests upon the students themselves, who seldom confide their troubles to their instructors, doubtless largely for fear that such action will be mistaken for solicitation of special favors in the final record.

31. School work will always run at a less than maximal degree of efficiency until data such as have been presented in this investigation are in the hands of the instructors and full use of these facts is made for each student.

BIBLIOGRAHY

It has been a difficult task to select a bibliography suitable for this investigation. We are safe in assuming that the standard texts on educational psychology and on the measurement of intelligence should be included. Treatises on the experimental study of mental ability are legion. Many af them deal with the same mental tests which we have just been using. Only a limited number of such references has been included and only those which have some direct bearing upon this study. The chief value derived from such references to periodical literature lies not so much in the norms which are frequently included, as in the suggestions made about the technique of testing.

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THE RELATION OF INTELLIGENCE TO AGE IN NEGRO CHILDREN.[1]

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The Army tests have shown negroes of draft age to be inferior to adult whites and a number of investigations, notably that of Strong,[2] have shown negro children to be inferior to white children. As yet, however, we have no data in the nature of a median I. Q., for all ages will show the extent to which the inferiority of negroes is dependent on age.

Our investigation was undertaken with this point in mind, that is the examination of a sufficient number of children between the ages of five and nine to give at least a tentative norm for each of these ages and of a sufficient number between the ages of ten to fifteen to give a tentative norm of these ages combined.

The subjects were 180 negro children[3] tested by the writer in New Orleans during June and July 1921, and 63 tested in the schools in the neighborhood of Philadelphia during the two preceding years. Of the 63 negroes tested in Pennsylvania 36 were examined by the writer and 27 by four graduate students.[4] Replies in the latter cases were recorded as far as possible verbatim and were graded in consultation with the writer.

The negroes tested in New Orleans were selected in the following manner: 112 came from the negro playground operated by the city, 26 from the Thomy Lafon School, a negro public school taught by negro teachers, 23 from the demonstration classes in a summer normal school operated by Straight University, 10 from a negro private school and 9 from a colored Industrial Home and School. In all cases both as to playground children above 7 years and children tested in the New Orleans schools the children

[1]Read before the American Psychological Association, December, 1921.
[2]*Strong, A. C.*s Three hundred and fifty white and colored children tested by the Binet Scale. *Ped. Sem.*, 1913. 20: 485-515.
[3]These subjects were secured through the cooperation of Superintendent Gwinn of the New Public Schools and Mrs. A. J. Stallings of the New Orleans Playground Commission.
[4]For assistance in giving these twenty-seven examinations the writer is indebted to C. Baechle, H. Hanna, I. Neterer and K. Smith.

had been for at least a year previous to the time at which the examinations were made under the instruction of negro teachers. The Pennsylvania negroes were in schools which contained both whites and negroes and had white teachers. The procedure followed in New Orleans was to test every child between the ages of five and nine except in the case of the Thomy Lafon School where the 26 children tested were taken in the order in which they were seated. As they were seated without reference to relative ability this seemed as fair as any other method of random selection.[5] In the Pennsylvania schools the procedure was to test all negroes between the ags of five andfifteen.

Of the 243 children 129 were boys and 114 were girls. There where 54 of ages five and six combined, 28 boys and 26 girls; 50 seven year olds, 25 boys and 25 girls; 50 eight year olds, 25 boys and 25 girls; 49 nine year olds, 25 boys and 24 girls, and 40 children between the ages of ten to fifteen, 26 boys and 14 girls. As to social status 33.7% were of very inferior, 58% were of inferior, 6.5% were of average, and 1.6% of very superior social status. None were of superior social status.[6] With four exceptions, two in each of the younger groups, all of the children of average and very superior social status were in the eight, nine and ten to fifteen year old groups.

All were tested by the Stanford Revision of the Binet tests. The The school children were tested in a vacant room or hall, the Playground children in a room on the Playground. The conditions for testing were unusually good since all of the children were anxious to take the tests and showed none of the initial shyness so frequently met with in young children. Whenever possible the children were tested in order of age beginning with the youngest. This rule was adhered to strictly in the schools but several exceptions were made in the case of Playground children. We found no evidence of coaching of younger children by older though the few cases of younger children who were tested towards the end of the investigation were closely questioned.

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[5]The writer wishes to call attention to an error in results which may easily arise when teachers are allowed to select the children. It is natural that they will select the best, and not the average or poor children, to be tested first. Especially is this the case if there is any question of collecting data for a comparison of two races and the teachers belong to one of the races represented. Unless all the children in the school are tested subsequently, the norm established will represent the superior instead of the average child. In two of the schools tested the teacher was allowed to select the first four children, all eight belonged in the top 25 per cent of the group tested.

[6]The division into social status groups by the occupation of the father was made on the basis of Taussig's five non-competing groups, i. e. unskilled, semi-professional and higher business and professional classes.

The results of the test are to be found in Table I.

TABLE I

I.Q.	Below 60	60-69.9	70-79.9	80-89.9	90-109.9	110-119.9	120-129.9	Total	Median Percentile	75 Percentile	25 Percentile
Age											
5 and 6 yrs.	0	0	1	14	27	9	3	54	100.0	106.6	89.5
7 yrs.	0	3	.6	9	30	2	0	50	90.9	96.6	85.3
8 yrs.	0	2	9	15	23	1	0	50	87.5	95.7	81.4
9 yrs.	1	5	8	20	14	0	1	49	83.9	92.2	79.2
10-15 yrs.	1	9	11	15	4	0	0	40	78.4	83.4	71
Total group	2	19	35	73	98	12	4	243	85.6	96.6	81
Percent	.82	7.8	14.4	30	40.3	4.9	1.64				

As the largest percentage of these children came from the inferior social status group our results are most nearly comparable with Terman's results for white children of inferior social status. The median I. Q. for this group of Terman's, all ages combined, is 93. If we may fairly assume this intelligence quotient to be constant for all ages, the I. Q. for negro[7] children ages five to six combined, which is 100, is 7 points above that of whites of the same social status. Seven year olds have an I. Q. of 90.9 or 2.1 points below that of whites. The median I. Q. for eight year olds is 87.5 or 5.5 points below that of whites, that of nine year olds is 83.9 or 9.1 points below that of whites, and that of ten to fifteen year olds is 78.9 or 14.1 points below that of whites of the same social status. There is also a corresponding decrease of the 25 and 75 percentiles. At ages five and six combined, the 75 and 25 percentiles are respectively 106.6 and 89.5, at age seven 96.6 and 85.3, at age eight 95.7 and 81.4, at age nine 92.2 and 79.2 and at ages ten to fifteen combined 83.4 and 71.

Combining age groups so that each contains at least 99 individuals we have the following results which are shown in Table II.

The median I.Q. for 104 negro children between the ages of five and seven is 93.5 or .5 of a point above that of native born whites of the same social status, that for 99 eight and nine year olds is 86 or 7 points below that of whites, and that for 139 eight to fifteen year olds is 83.3 or 9.7 points below that of whites of the same social status.

Though we have evidence of a decrease with increasing age of the quotients marking the limits of the middle 50%[8] in native born

[7]No data could be obtained as to the proportion of white blood at any age. This factor may play a part in the distribution of intelligence in any of these groups. It is, however, a manifest absurdity to assume that the proportion of white blood is increasingly lower in each age group from the five and six year olds to the ten to fifteen year olds and that this explains the decrease in the median I. Q. and in the 25 and 75 percentiles with increasing age.

TABLE II

I.Q. Below Age	60- 60	70- 69.9	80- 79.9	90- 89.9	110- 109.9	120- 119.9	Tot.	Med.	75 Per-centile	25 Per-centile
5, 6 and 7 yrs.	0	3	7	23	57	11	3	104	93.5	101	88
8 and 9 yrs.	1	7	17	35	37	1	1	99	86	94.7	79.6
8, 9 and 10 to 15 yrs	2	16	28	50	.41	1	1	139	83.3	92.3	75.6

whites the median I. Q. remains constant until age 13. Obviously then, age has an effect on the median I. Q. in negro children which it does not have in the case of native born whites. Had the median for the total group, 85.6, been taken as a criterion the negroes would have appeared inferior to whites by 7.4 points, the difference in this case being between an I. Q. which would place a child in the average group and one which would place it in the dull normal group. Actually very young negroes five and six years old have a median I. Q. of 100 or average for the average social status group and 7 points above that of whites of the same social status, while ten to fifteen year olds have a median I. Q. of 78.9 or one which would place a child in what is called by some writers the "borderline" group. There are no superior or very superior children beyond the age of ten and on the other hand the percentage of children with I. Q.s below 70 increases steadily except in the case of the eight year olds from 0% at ages five and six to 25% at ages ten to fifteen combined.

Though the decrease in I. Q. with increasing age is undoubtedly due to a genuine race difference[8] there are several factors which may also have had an effect.[10] Negro children are particularly poor in language tests of which there are a much larger percentage at the upper end of the scale than at the lower. The percentage of

[8]The results cited by Terman for native born whites (Stanford Revision of the Binet Tests, page 40, Terman and others, Warwicke and York 1917) show a steady decrease in the quotients at both extremes of the limits including the middle 50 per cent of I. Q.s made at each age, from 97-111 at ages five and six combined to 92-108 at ages eleven and twelve combined.

[9]*Odum, H W. Annals of the American Academy of Social and Political Science.* Nov., 1913, Vols. 48-50 pp 186-208. Results somewhat similar to ours were printed in this article when the Goddard revision of the Binet tests was applied to negro children in Pennsylvana, On page 102 of the article cited he says: "In the seventh year negro children were approximately as good as the white, and then they decreased to the thirteenth year regularly....." Though his results are open to the same criticisms as those of other investigators using the early revision of the Binet tests, they give added proof that our results are not due merely to some process of selection operative in the region from which most of our cases came.

[10]These results do not accord with those of Sunne, (Jour. of Applied Psychol., 1917, p. 82) Sunne states that "Negroes have greater facility in control of words," than have whites.

children between the ages of eight and nine, 99 in all, passing the eight year old vocabulary test is only 33. According to the method by which this test was standardized the percentage of children in the eight year old group passing this test should have been 65 and that in the nine year old group still higher. Our language medium would seem to be too complex for the stage of development which the negro has reached.[11] On the other hand the negro children were particularly good in tests involving rote memory and of these we have more at the lower end of the scale than at the upper. Another factor may be responsible for the superiority of negro children of ages five and six combined. Children of inferior mentality may not have had sufficient initiative to find their way to the Playground or may have been kept home from both Playground and school. Since compulsory education is in force in the districts from which both southern and northern negroes came, this would not apply to any group beyond the age of seven. But since the groups tested are relatively small, this or some other selective factor may have been operative in the five and six year old group.

The effect of sex on the median intelligence quotient is shown in Table III. At ages five and six combined girls are superior to boys; the median for girls is 100.5 and that for boys 94.8. At age seven girls and boys have the same median I. Q. At eight the median for boys, 88, is .5 of a point above that for girls, at nine the median for girls, 84.2 is .9 of a point above that for boys and at ages ten to fifteen inclusive the median for boys, 78.4 is .9 of a point above that for girls.

TABLE III.

I.Q.	Below 60	60-69.9	70-79.9	80-89.9	90-109.9	110-119.9	120-129.9	Median	Total Number
Age 5-6									
Girls	0	0	1	4	13	5	3	100.5	26
Boys	0	0	0	10	14	4	0	94.8	28
Age 7									
Girls	0	1	4	4	15	1	0	90.9	25
Boys	0	2	2	5	15	1	0	90.9	25
Age 8									
Girls	0	1	6	6	11	1	0	87.5	25
Boys	0	1	3	9	12	0	0	88	25
Age 9									
Girls	0	2	4	11	6	0	1	84.2	24
Boys	1	3	4	9	8	0	0	83.3	25
Age 10-15									
Girls	0	4	3	6	1	0	0	77.5	14
Boys	1	5	8	9	3	0	0	78.4	26

[11]The negro children in the south would tend to have any language difficulty due to race increased since the teachers were of their own race.

Table IV contains the median I. Q. and the distribution of I.Q.s when consecutive ages are combined to give fifty or more children in each group. The median I. Q. for five to seven year old girls is 93.6, that for five to seven year old boys is 93.2 or .4 of a point below that of girls. The median I. Q. for eight to nine year old boys is 86.7 or .7 above that of girls. The median I. Q. for eight to fifteen year old boys is 83.3 or .4 below that of girls. The group medians except at ages five and six combined are practically the same, but at these ages girls are markedly superior to boys. In the total group there are many more girls of superior mentality than boys. Four girls and no boys have I. Q.s above 120 and seven girls and five boys have I. Q.s between 110 and 119.9. Again the proportion of boys of very inferior mentality is much larger than that of girls. Of the twenty-one children with I. Q.s below 70 thirteen are boys and eight are girls. That is to say, there are twice as many girls as boys in the superior to very superior group and almost twice as many boys as girls in the very inferior group.

TABLE IV.

I.Q.	Below 60	60-69.9	70-79.9	80-89.9	90-109.9	110-119.9	120-129.9	Med.	75 Percentile	25 Percentile	Total
Age 5-7											
Girls	0	1	5	8	28	6	3	93.6	102.2	89.7	51
Boys	0	2	2	15	29	5	0	93.2	101.1	85.7	53
Age 8-9											
Girls	0	3	10	17	17	1	1	85.4	94.8	77.3	49
Boys	1	4	7	18	20	0	0	86.7	92.6	80.5	50
Age 8-15											
Girls	0	7	13	23	18	1	1	83.7	92.5	75	63
Boys	2	9	15	27	23	0	0	83.3	92	75.6	76

Our findings as to differences in intelligence between boys and girls are somewhat similar to those of previous investigators. Sunne[12] found that negro girls on the whole were superior to boys by both the Yerkes Point Scale and the Binet tests, though at ages eight, nine and eleven girls were inferior to boys by the Binet tests. They were superior at all ages by the Point Scale. Pyle[13] found negro girls superior to boys, when averages alone are considered. According to our findings negro girls are superior to boys where either the average I. Q. or the median for the total group is taken. Girls are actually superior to boys only at ages five and six combined and at age nine. The sex difference is very slight at all ages except five and six.

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[12] *Ibid*, cit, page 72

[13] The Mind of the Negro Child, *School and Society* 1915, I:357-360.

Conclusions.

1. The median I. Q. for negro children decreases with increasing age from age six to ages ten to fifteen combined.

2. At ages five and six negroes are superior to whites of the same social status. At all ages beyond six negroes are inferior to whites and this inferiority increases with increasing age.

3. Though there are more girls than boys with intelligence quotients above 110 and more boys than girls with intelligence quotients below 70, the differences due to sex are slight except at ages five and six. At these ages girls are markedly superior to boys.

THE COMPUTATION OF PEARSON'S r FROM RANKED DATA

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I.

Psychologists frequently desire a reliable coefficient of correlation where one or both of the arrays of data consist of ranks. This is particularly the case in the evaluation and weighting of vocational tests where often the only obtainable criterion is a series of ranks, though all the test data will usually be in ordinary units. Spearman's rank-difference coefficient of correlation can not be used satisfactorily as a basis for regression equations[1] and even if it were so used, the prediction of a criterion in terms of a more or less accidental series of ranks would have little meaning. A method of obtaining Pearson's r from ranks must accordingly be found if such situations are to yield readily to the vocational psychologist.

The proposed method is, in brief, to convert the series of ranks into an array of scores on a convenient linear scale, the linear scores then to be used in the computation of r in the ordinary way. In translating the ranks into linear units, it is assumed that the ability in question is distributed according to the Gaussian law. It then becomes easy with the aid of a table computed from that of Sheppard [2] to tell the percent of cases falling between the various successive points of the scale. For example, if the range of ranked ability be assumed arbitrarily as cut off at 2.5σ in each direction, and that the limits of a 10-point scale exactly coincide with the respective extremes of this range, the highest 1.7% of the ranked cases will fall between scores 9 and 10. The next 4.4% of the cases will fall between 8 and 9, the next 9.3% between 7 and 8, the next 15.2% between 6 and 7, the next 19.4% between 5 and 6, and so on. These values being known, it is a simple matter to take the first 1.7% of any given series of ranks and assign to them the central value of the highest scale interval, to assign to the next highest 4.4% of ranks the central value of the next highest scale interval, and so on. Thus if n be 60, 1.7% of this series yields in round numbers, 1 case, which accordingly receives the score of 9.5; 4.4% of 60 yields 3 cases at 8.5; 9.3% yields 5 cases at 7.5. Table I shows the data suggested above, worked out fully and arranged in a systematic manner.

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[1] *Kelley, Truman Lee.* Tables: To Facilitate the Calculation of Partial Coefficients of Correlation and Regression Equations, p. 24.
[2] *Pearson, Karl.* Tables for Statisticians and Biometricians, pp. 2-8.

TABLE I

Score values on a linear scale	Per cent of cases to be given each score	Number of cases receiving each score where n is 60
(A)	(B)	(C)
9.5	1.7%	1
8.5	4.4%	3
7.5	9.3%	5
6.5	15.2%	9
5.5	19.4%	12
4.5	19.4%	12
3.5	15.2%	9
2.5	9.3%	5
1.5	4.4%	3
.5	1.7%	1
Mean, 5.0	Total, 100.0%	Total, 60

II

It may be desired for some purpose to translate ranked data into scores of a linear scale by individual ranks instead of by groups as above. The method of doing this and the table used, depend upon the same principles as the method just described. If c represent the rank of a given subject in a series and n the number of subjects ranked, then the formula

$$\% = \frac{100\ (c - .5)}{n}$$

yields values such as are given in column A of Table II. This figure is practically a percentage expression of the distance in rank of a given subject from the good or efficient extreme of the distribution of ability in question. Column B of this table gives the corresponding score on a 10-point scale by steps of .1 point.

The operation of this second method may be illustrated by a sample computation. Suppose n to be 25 and c to be 1. Substituting in the above equation we have,

$$\% = \frac{100(1 - .5)}{25}$$

$$= 2$$

Looking up 2 in column A of Table II, we find the value nearest it to be 1.96. In column B opposite this entry is found the corresponding score or linear scale value, 8.9. If there are no fractional ranks in the series, the % values after rank 1 may be determined by merely adding successively $\frac{100}{n}$ (in the above case, 4) until the whole series of ranks has been traversed.

TABLE II

% (A)	Score (B)	% (A)	Score (B)	% (A)	Score (B)
.09	9.9	22.32	6.5	83.31	3.1
.20	9.8	23.88	6.4	84.56	3.0
.32	9.7	25.48	6.3	85.75	2.9
.45	9.6	27.15	6.2	86.89	2.8
.61	9.5	28.86	6.1	87.96	2.7
.78	9.4	30.61	6.0	88.97	2.6
.97	9.3	32.42	5.9	89.94	2.5
1.18	9.2	34.25	5.8	90.83	2.4
1.42	9.1	36.15	5.7	91.67	2.3
1.68	9.0	38.06	5.6	92.45	2.2
1.96	8.9	40.01	5.5	93.19	2.1
2.28	8.8	41.97	5.4	93.86	2.0
2.63	8.7	43.97	5.3	94.49	1.9
3.01	8.6	45.97	5.2	95.08	1.8
3.43	8.5	47.98	5.1	95.62	1.7
3.89	8.4	50.00	5.0	96.11	1.6
4.38	8.3	52.02	4.9	96.57	1.5
4.92	8.2	54.03	4.8	96.99	1.4
5.51	8.1	56.03	4.7	97.37	1.3
6.14	8.0	58.03	4.6	97.72	1.2
6.81	7.9	59.99	4.5	98.04	1.1
7.55	7.8	61.94	4.4	98.32	1.0
8.33	7.7	63.85	4.3	98.58	.9
9.17	7.6	65.75	4.2	98.82	.8
10.06	7.5	67.48	4.1	99.03	.7
11.03	7.4	69.39	4.0	99.22	.6
12.04	7.3	71.14	3.9	99.39	.5
13.11	7.2	72.85	3.8	99.55	.4
14.25	7.1	74.52	3.7	99.68	.3
15.44	7.0	76.12	3.6	99.80	.2
16.69	6.9	77.68	3.5	99.91	.1
18.01	6.8	79.17	3.4	100.00	.0
19.39	6.7	80.61	3.3		
20.83	6.6	81.99	3.2		

In case the $\frac{100}{n}$ should turn out to involve a large decimal, the additions may be carried out very easily on an ordinary adding or computing machine. The results of the conversion of a series of ranks by the method just described, is shown in Table III.

TABLE III

Rank	%	Score
1	2	8.9
2	6	8.0
3	10	7.5
4	14	7.1
5	18	6.8
6	22	6.5
7	26	6.3
8	30	6.1
9	34	5.8
10	38	5.6
11	42	5.4
12	46	5.2
13	50	5.0
14	54	4.8
15	58	4.6
16	62	4.4
17	66	4.2
18	70	3.9
19	74	3.7
20	78	3.5
21	82	3.2
22	86	2.9
23	90	2.5
24	94	2.0
25	98	1.1

The first column shows a series of 25 ranks. The second column shows these ranks converted into % values by the formula. The third column shows the corresponding score on a 10-point scale to the nearest .1 point, as given in Table II.

III

The above arbitrary choice of a scale of 10 steps into the units of which all ranked criteria are to be converted, calls for some comment. That the scale should be arbitrary is obviously inevitable. A scale of 10 points was chosen because of its simplicity and general intelligibility. If desired, however, the decimal point may be disregarded in the scale values, in which case there results a 100-point scale. A 10-point scale has the additional advantage that each step corresponds to a fairly definite concept of ability. A convenient set of ability concepts is shown in the following table, each concept opposite its corresponding step of the scale.

Scale unit	Ability concept
10	maximal
9	excellent
8	very good
7	good
6	above average
5	average
4	below average
3	poor
2	very poor
1	inferior
0	minimal

It may even be that in certain cases, particularly in industry, final prediction in terms of ability concepts would be more acceptabie than in numerical scale units.

Occasions will sometimes arise where it will be desirable to make predictions in terms of some other scale such, for example, as the ordinary percentage scale of school marks. In such cases the ranks should first be converted into units of the 10-point scale by one of the methods described above. These scores may then be converted into the units of any scale that may be desired by the special conversion formula mentioned below.

Despite the occasional necessity of predicting criteria in terms of the most divers units, in vocational guidance there is a distinct practical advantage in making predictions in terms of some simple uniform scale such as that suggested above. Ideally the vocational adviser should be able to tell the subject which of all the vocations in the world he is best fitted to pursue. Practically he ought to be able to tell the subject *relatively* how much aptitude he has for a limited number of vocations. This demands a separate prediction on each vocation, while comparability of predicted aptitude demands a uniform prediction scale for all. Take a typical vocational group such as typing, stenography, bookkeeping and general office work. Ordinarily the criterion of the first would be the number of words typed per minute, the criterion of the second would be the number of words written down per minute, the bookkeeping might be in terms of school marks, while the original criterion at least, on office workers, might be in terms of ranks in a group of 60, say. Now suppose, with a view to discovering which of the four vocations would be most likely to bring success to a given individual, his aptitude in each were predicted by means of appropriate regression equations. At least to the uninitiated, it is by no means obvious whether a certain number of words typed per minute would be a better or worse score than some other number of words writ-

ten in shorthand, or whether either of these would be better or worse than a certain school grade or a certain rank in a group of 60, to say nothing of how much better or worse. As the result of this lack of natural comparability of the various prediction scales, the vocation of greatest promise might still be far from evident after the labor of making the predictions had been performed. If, on the other hand, prediction on all four criteria had been made in terms of a single uniform scale, the relative promise of the various vocations would be instantly evident to any one and the object of making the predictions would be attained.

There is no technical obstacle in the way of the adoption by psychologists of a uniform criterion scale for purposes of vocational prognosis. The simplicity of the procedure where the criterion originally has been obtained in terms of ranks, has been described. In many cases the criterion will be obtained in terms of some linear scale such as the number of words typed per minute or the average number of boxes made per day in a factory. Such scores may readily be converted into units of any standard uniform scale desired, by means of a special conversion formula. This will be found in Vol. VI., p. 298f of this Journal, together with examples of its use. In using this formula to convert linear scores into units of a 10-point scale, the mean of the 10-point series should be taken as 5 and the standard deviation as 2. These values will need to be substituted in the conversion formula.

A COMPARISON OF THREE TESTS OF "GENERAL INTELLIGENCE"

By Morris S. Viteles,
University of Pennsylvania

This study concerns itself with the examination of fifty-nine students of the Wharton School of Finance and Commerce of the University of Pennsylvania with three tests of "general intelligence." The purpose of the study is, 1: to measure the variability in performance of the members of a selected, homogenous group in a number of accepted tests of general intelligence, 2: to measure the relationship between success in each of these tests and school grades, the measures of academic success.

METHOD.

The Otis General Intelligence Test, the Army Alpha and the Morgan Mental Test were used in this investigation. The tests were given within a period of two months in the order in which they are mentioned. They were all given between eleven and twelve in the morning to the members of a class assembled for a lecture in Psychology. The men taking the tests were juniors and seniors in the Wharton School of Finance and Commerce of the University of Pennsylvania.

The average of the grades in all courses for a period of the academic year preceding the one in which the tests were given was taken as the measure of academic success. The grades given in the University of Pennsylvania are D (Distinguished), G (Good), P (Passed), N (Not passed) and F (Failed). A student who receives N in a course is entitled to a re-examination; a student who receives F is not allowed to take a re-examination but must repeat the course. The following numerical values were assigned to each of these grades:

D equals 85
G equals 75
P equals 65
N equals 55
F equals 35

For each student the total value of the grades for the year was obtained by multiplying each grade by the value asigned to it and finding the sum. This total was divided by the number of courses to give the average grade for the year. The minimum number

of courses taken during the year by any student was found to be 8: the maximum number was found to be 20 and the average 15.5.

RESULTS.

A Treatment and Analysis

1.—The variability of the performance in the test was first investigated by a study of the rank order displacements of the individuals in the group when one test is compared with the others. The results of this analysis are presented in **Table 1**, below:

TABLE I

TABLE OF RANK DIFFERENCES
INTELLIGENCE TESTS.

	Alpha-Otis		Alpha-Morgan		Otis-Morgan	
	No.	%	No.	%	No.	%
0- 5.5	30	50.9	20	33.9	17	28.9
6-10.5	10	16.9	11	18.7	15	25.5
11-15.5	8	13.6	12	20.3	7	11.8
16-20.5	6	10.0	6	10.0	6	10.0
21-25.5	2	3.4	5	8.5	6	10.0
26-30.5	2	3.4	2	3.4	4	6.8
31-35.5	1	1.8	2	3.4	1	1.8
36-40.5	0	0	0	0	2	3.4
41-45.5	0	0	0	0	1	1.8
46-50.5	0	0	1	1.8	0	0
51-55.5	0	0	0	0	0	0
56-58-	0	0	0	0	0	0
Total	59	100.0	59	100.0	59	100.0

The maximum displacement in rank of any given individual on the Army Alpha and Otis Test is 32.0. The minimum is 1.0. The average displacement is 8.1 and the median displacement is 5.5 The correlation of the tests by the rank difference method (Pearson formula) gives a coefficient of plus 0.76.

Between the results of the same individual on the Alpha Test and the Morgan Test there is greater discrepancy, on the average, than between the Army and the Otis Tests. The maximum rank order displacement between these two tests is 49.5; the minimum is 0.0. The average displacement is 11.2 and the median is 10.0. The co-efficient of rank and order correlation is plus 0.62.

The greatest rank order displacement exists between the Morgan Test and the Otis Test. The maximum displacement in this case is 46.0; the minimum is 0.0. The average is 12.3 and the median is 8.0. The value of the rank order co-efficient of correlation between these two tests is plus 0.51.

This analysis shows that there is less variability in the performance of the individuals of a selected group with the Army Alpha and the Otis Test than between Alpha and the Morgan Test. The greatest variability in performance comes when the same individ-

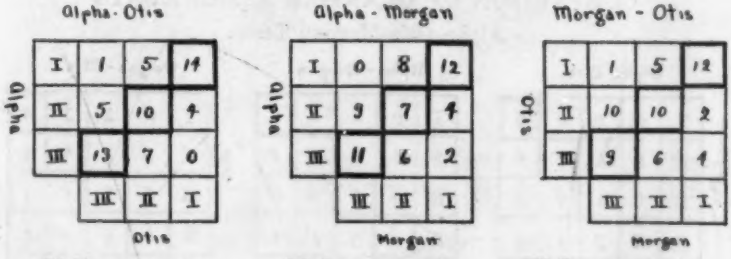
uals are given the Morgan Test and the Otis Test, the analysis of individual displacements and the low value of the co-efficient of rank and order correlation indicating that the chance for a given individual to be assigned to closely related positions in rank order distribution of the results of the two tests is a small one.

2.—The second method of measuring the extent of variability in the performance of a group in a series of tests is *a* to divide the group into tertiles, higher, middle and lower and to compute the number of individuals assigned to the same tertile by the different tests; and *b* to divide the group into quartiles and compute in the same way, the number and percentage of individuals assigned to the same quartiles by the different tests. The results of such an analysis are presented in Charts 1 and 2.

CHART I

COMPARISON OF TERTILE ASSIGNMENTS

Alpha-Otis-Morgan Tests.



62.7 per cent. in same tertile

50.8 per cent in same tertile

52.5 per cent. in same tertile

The chance that a given individual will be assigned to the same tertile by any two tests is 33⅓ percent. The highest percentage of individuals assigned to the same tertile by any two tests is 62.7% (Alpha and Otis), only twice the percentage assigned by chance. The lowest assignment is 52.8⅓, or only one and a half times the chance assignment. (Alpha and Morgan.)

Chart 1 shows not only the percentage of individuals assigned to the same tertile by two different tests but the detailed distribution among the tertiles. The first figure in Chart 1 shows that out of the twenty individuals assigned to 1, or the lower tertile in the Alpha Test, 1 or 5% is found in the 3 or higest tertile in the Otis Test; 5 or 25% are found in the middle tertile according to the Otis results and the remaining 14, or 70% are found in the 1, or lower tertile in the distribution of the results of the examination with the Otis Test. On the other hand by reading vertically up

from the figures on the abscissa it can be found that out of the 13 individuals assigned to 3 or the higher tertile by the Otis Test 13 or 68% are found in 3 or the higher tertile in the distribution of the Alpha results; 5 or 26.8% are found in the middle tertile in the distribution of the Alpha results and 1 or 5.2% in 1 or the lower tertile.

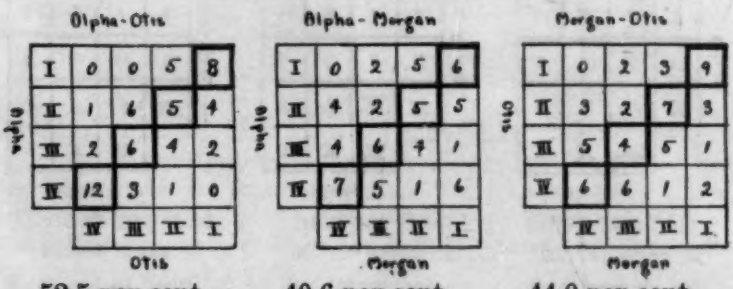
The remaining figures in this chart, and in the charts similar to it presented elsewhere in this report show in the same way the number of individuals of a given tertile or quartile in the distribution of results on one measure assigned to the various tertiles or quartiles in the distribution of the results on another measure.

b/—In addition to the division of the group into tertiles on each of the tests a division was made into quartiles. The results of this analysis are presented in Chart 2.

CHART II

COMPARISON OF QUARTILE ASSIGNMENTS

Alpha-Otis-Morgan Tests.



52.5 per cent. in same quartile

40.6 per cent. in same quartile

44.0 per cent. in same quartile

The chance that any individual will be assigned to the same quartile by any two tests is 25%. The greatest percentage of individuals assigned to the same quartile by any two tests is 52.5% (Alpha and Otis). The smallest percentage is 40.6% (Alpha and Morgan). The chart shows the number of individuals assigned to a given quartile in a given test assigned to each of the quartiles by the other tests.

A survey of this analysis shows that with reference to the variability in the assignment to tertile and quartile the greatest difference exists between the Alpha and the Morgan Tests and the least difference between the Alpha and the Otis. Otis and Morgan show almost as much variability in the assignment of given individuals to tertile and quartile as do Alpha and Morgan. Only

in the case of the tertile assignment in Alpha and Otis is the percentage of assignments to same tertiles high enough to show that the tests measure somewhat simliar abilities.

3.—The variability in the performance of a group of individuals a number of tests may be due to a disagreement among the authors of the test on the question of what constitutes general intelligence. As a result of such disagreements different material, testing different abilities, and weighted differently, may be included in the test. The extent to which the tests agree in the measurement of the same intelligence will be indicated in the co-efficient of correlation. Such co-efficients of correlation have been computed for these tests. These co-efficients, computed by the product moment method, are presented in Table 2, and Table 3.

TABLE II

Coefficients of Correlations
Alpha, Morgan and Otis Tests

Morgan-Alpha	r 0.52±.071
Morgan-Otis	r 0.59±.061
Alpha-Otis	r 0.69±.048

TABLE III

Partial Co-efficients of Correlation
If Morgan equals 1
If Alpha equals 2
If Otis equals 3

r12.3	plus 0.21±.091
r13.2	plus 0.37±.080
r23.1	plus 0.54±.07

That similar elements are present in all three tests is revealed both by the value of the co-efficients of correlation between the tests and by the fact that when the influence of the elements of one test present in the other two is removed in the correlation of the other two tests, by the method of partial correlation, the resultant co-efficient of correlation between the two tests is greatly diminished. There is, however, a difference in the degree of similarity between the elements of the three tests. Alpha and Otis are most similar in the elements contained, with a co-efficient of correlation high enough to be of considerable significance. Morgan and Alpha are least similar. As a matter of fact the elimination of the elements common to Otis in the correlation of Morgan and Alpha reduces the co-efficient of correlation of Morgan and Alpha to plus. .21±.091, much below the level of significance. In the same way the elimination of the elements common to Alpha in the correlation of Morgan and Otis reduces the co-efficient of

correlation of these two tests to plus 0.37±.080, also below the level of significance. The elimination of the Morgan elements in the correlation of Otis and Alpha does not affect seriously the value of the co-efficient of correlation between these two tests, demonstrating more conclusively the fact that, to a great similar extent elements are tested by Otis and Alpha. It is by reason of the similarity of the elements tested by the two that there is least variability in the performance of the group in these two tests.

B.—Comparison of Test Results with School Grades.

The second part of the study was designed to measure the relationship between success in each of these tests and success in school, as represented in school grades. This part of the study was naturally suggested by the increased use of tests of "general intelligence" as criteria for college entrance, and purposes to give some slight additional evidence, of different accepted measures of "general intelligence" in predicting academic success.

The statistical treatment of these results parallels that given above, but in addition to test results, school grades are introduced and become the objective standard or criterion of comparison in each case.

1.—The difference in rank order assignment of the individuals of the group in each test as compared with school grades is given in Table IV below.

TABLE IV

TABLE OF RANK DIFFERENCES, INTELLIGENCE TESTS AND SCHOOL GRADES.

Units of Rank Difference	Alpha No.	School %	Otis No.	School %	Morgan No.	School %
0- 5.5	13	22.0	12	20.3	13	22.0
6-10.5	7	11.8	8	13.5	7	11.8
11-15.5	10	16.9	10	16.9	12	20.3
16-20.5	9	15.2	6	10.0	4	6.8
21-25.5	5	8.5	8	13.6	8	13.6
26-30.5	5	8.5	8	13.6	3	5.1
31-35.5	3	5.1	2	3.4	5	8.5
36-40.5	2	3.4	3	5.1	0	0
41-45.5	4	6.8	1	1.8	3	5.1
46-50.5	1	1.8	1	1.8	4	6.8
51-55.5						
Total	59	100.0	59	100.0	59	100.00

The maximum displacement of any individual in rank order when the Otis scores are compared with school grades is 49.0, the minimum being 0.5. The average displacement of the group is 17.4; the medium is 15.5. The co-efficient of correlation, by the rank order method, is plus 0.22.

Between the Alpha Test and the School grades the maximum displacement is 48.0. The minimum is 0.5. The average is 17.4

and the median is 15.5. The co-efficient of rank order correlation is plus 0.22.

In the comparison of Morgan Scores with school grades even greater discrepancy in rank order placement is revealed. The maximum displacement in this case is 49.0 and the minimum 0.0. The average is 20.8 and the median 15.5. The co-efficient of correlation by the rank order method between the two criteria is plus 0.13.

These results indicate that there is no greatly significant relationship between the scores on any of the tests and school grades. The average displacement in rank order between each of the test scores and the school grades is high, and the co-efficient of correlation is in each case, low. Of the three tests the Otis scores show the greatest relationship with school grades and the Morgan scores the least.

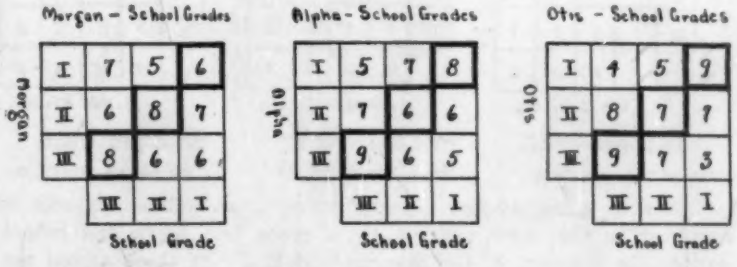
2. In order further to examine the relationship between success in each of these tests with academic success an analysis was made of the variability in tertile and quartile assignments of each test as compared with tertile and quartile assignments made on the basis of an array of school grades.

a/—The analysis of tertile assignments is presented in Chart 3 below.

CHART III

COMPARISON OF TERTILE ASSIGNMENTS

Tests and School Grades



in same tertile	in same tertile	in same tertile
37.3 per cent.	38.9 per cent.	42.3 per cent

In view of the well defined tendency of school administrators to divide children of the same chronological age or of the same peda-

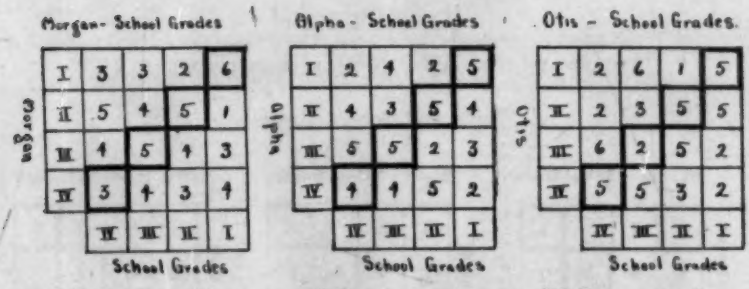
gogical age into three classes, on a basis of differences in mental endowment, for purposes of education, the comparison of tertile displacements between test scores and school grades is particularly significant. On the basis of chance alone 33⅓% of those examined would be assigned to the same tertile by both school grades and test scores. In the charts above, as it has been stated before, the numbers enclosed in heavy lines represent the number of individuals assigned to the same tertile both by school grades and test scores.

By the Morgan test and school grades 37.3% of the individuals examined are assigned to the same tertile; by the Army Alpha Test and school grades 38.9%; by Otis scores and school grades 42.3%. In each case the variability in assignment to tertiles is high, the percentage of parallel assignments being in no case very much higher than the chance assignment. Of the three, however, the Otis scores parallel most closely the assignment by school grades.

b/—In Chart 4 below is presented the analysis of quartile assignments when tests scores are compared with school grades.

CHART IV

COMPARISON OF QUARTILE ASSIGNMENTS
Tests and School Grades



32.2 per cent.	32.2 per cent	28.8 per cent.
in same quartile	in same quartile	in same quartile

There is a twenty-five percent chance that individuals will be assigned to the same quartile by a given test score and school grade. In the case of the Morgan test 32.2% of those tested are placed in the same quartile to which they are assigned in the distribution of school grades. The same percentage, 32.2%, are assigned to the same quartiles by Alpha score and school grades, and 28.8% by Otis scores and school grade.

The charts also show how many individuals assigned to a given

tertile or quartile by test is assigned to each of the school grade quartiles and conversely, the number of those assigned to a given tertile or quartile by school grade assigned to each of the tertiles in the distribution of test results.

A summary of the results shows that no well defined tendency for those rating either high or low in school grades to rate high or low in any of the tests. There is a vague suggestion of such a grouping in the case of the Otis Test and school grades, 50% of those in Tertile 1, the lower tertile in this test being in the lower tertile in school grades, and 47% of those in the higher tertile in the test being in the higher tertile in school grades, but even here the percentages are not particularly significant, and they are less significant in the case of the other tests.

3.—In order to determine whether similar elements are involved in success in each of these tests and academic success in the Wharton School as portrayed in school grades, the scores in each test were correlated with school grades by the product moment method. The co-efficient of correlation so obtained are presented in Tables 5 and 6 below.

TABLE V.

Co-efficients of Correlation
Test Scores and School Grades

Morgan-School Grades	r plus 0.06
Alpha-School Grades	r plus 0.21
Otis-School Grades	r plus 0.24

TABLE VI.

Partial Co-efficients
If Morgan equals 1
If Alpha equals 2
If Otis equals 3
If School G equals 4

r 14:23 equals —0 .09
r 24:13 equals +0. 04
r 34:12 equals +0 .11

By the method of multiple correlation
R 4:123 equals Plus 0.252

In no case is the correlation between test scores and school grades significant. The elimination of the elements common to the other two tests in the correlation of any test with school grades diminishes the value of the co-efficient of correlation of the test with the school grades. Altho all the co-efficients are insig-

nificant in value the highest co-efficient is given by the correlation of Otis scores with school grades.

The correlation of the combined tests with school grades by the method of multiple correlation gives a co-efficient of plus 0.252, indicating that not even the battery of three tests has great significance in the prediction of academic success in the Wharton School.

CONCLUSIONS.

1.—The discrepancy in the results of individual members of the group on the different tests of "general intelligence" leads to the conclusion that the mental ability measured by each of these tests is not the same. They are all called tests of "general intelligence" but it cannot be concluded from this investigation that there is a similar complex or pattern of abilities measured by the three tests.

2.—Greater similarity in the individual elements of the test exists between the Otis and Alpha tests than between the Morgan tests and either of the first two. With regard to the mental factors involved in performance, the Morgan test and the Alpha test show the greatest dissimilarity.

3.—The comparison of test results with academic grades indicates that none of these three tests of "general intelligence" can be used in the prediction of academic standing in the Wharton School. It is possible, of course, that in the examination of an unselected group of applicants for entrance into the Wharton School the potential failures might be picked by one or all of these tests, but the statistical analysis presented in this report throws no light upon this problem.

DISCUSSION OF RESULTS.

The most important problem raised by these results is that of determining which of these three tests measures that which we are calling "general intelligence." It is quite possible that this problem will not be solved until we are able to agree upon a definition of "general intelligence." No attempt will be made to give such a definition in this article or to determine which of these tests is the best measure of "general intelligence." The purpose of this article is merely to point out the great discrepancy in the standing of the individual members of a group on three tests which are presumably designed to measure the same mental ability. The fact that there is greater discrepancy in the individual standing of the

members of the group when the Morgan test is compared with the Alpha and Otis than when these two tests are compared with each other, is in itself, no indication that the Morgan test is less a test of "general intelligence" than are the other two tests. The fact that none of the tests correlate with academic standing is not necessarily a sign that any or all of the tests do or do not measure "general intelligence." The finding of this study are only of importance in so far as they point out the need for evaluating very carefully tests which are proposed for the measurement of "general intelligence" for purposes of education, selection of workers in industry, or for general experimental purposes.

The absence of significant correlation, rank order assignment, and tertile and quartile assignment between test results and school grades is significant only in so far as it points out the necessity for determining exactly to what extent the abilities required for success in any test of "general intelligence" are factors in determining academic standing in any of the schools of a University. It is quite possible that the ability measured in the tests used in this investigation are not the same as those required for sucsuccess in a specialized school of business such as the Wharton School of Commerce and Finance of the University of Pennsylvania. A careful comparison between test results and the success and failure of individuals selected for each of the specialized schools of the University is necessary in order to determine the value of a given test of "general intelligence" as part of the Entrance Requirements of any University. The comparison of test results and academic standing of the pooled data from the different schools of the University is not sufficient. The pattern or group of abilities or the general competency required in one school is undoubtedly different than those required in another, and a test of "general intelligence" which is applied successfully in the prediction of academic success in one school may be altogether useless for prediction of academic success in another. It may be necessary for the psychologist to introduce in his thinking on this subject a concept of what might be called **specialized general intelligence** or **specialized performance pattern** or **ability-group-pattern** representing the pattern of specific mental ability necessary for success in a given specialized field such as engineering, business, etc., —the professions such as distinguished from the high commercial jobs, etc. That there is some recognition of such a problem is indicated in the appearance of such tests as the "Thurstone Test for Engineering Aptitude" and the "Otis Test of General Intelligence for Business Institutions" and the reported plan of the

School of Business Administration of Harvard to use a special test of "general intelligence" as part of its entrance requirements.

The desirability of making further investigations along this line is pointed out to some extent by the absence of correlation between the test results and academic standing in the Wharton School. In view of the purpose of this article merely to present some additional statistics on three tests of "general intelligence" in order to point out the need of evaluating more carefully proposed measures of "general intelligence" the further discussion of this problem will be left to another article.

GROUP INTELLIGENCE EXAMINATIONS FOR PRIMARY PUPILS

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Part I.

A BRIEF SURVEY OF EXISTING EXAMINATIONS.

In 1919 the first successful attempt was made to construct group intelligence examinations for primary pupils. During this year four primer tests were published. One of these, the preliminary form of the present Haggerty Intelligence Examination Delta 1[1] was given to a large number of pupils in the Virginia School Survey. Almost contemporaneous with it, came the publication of the Lowell Group Intelligence Scale, the Pressey Primer Scale, and the Myers Mental Measure. Since this time the activity in this field has been great and a number of other examinations have appeared at odd intervals. At the present time, there are about fifteen examinations designed to test the mental abilities of pupils from kindergarten through the fourth grade. These tests, although all intended for group use, vary widely in the kinds of exercises they contain, the total number of items, the length of time taken to give, directions, methods of scoring, and accessory materials. They differ even more in the apparent care exercised in construction, the completeness of statistical data, and useableness as practical instruments in the hands of the teacher.

Some of these examinations are not on the market, nor is there any published literature describing them. The list given below is believed to contain all that have been devised, and they have been arranged in the order of their appearance so far as this has been possible to ascertain.[2]

(1919) Haggerty Intelligence Examination, Delta 1[3]
(1919) Lowell Group Intelligence Scale for Primary Grades[4]
(1919) Myer's Mental Measure[5]

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[1] Haggerty, M. E., *Virginia Public Schools*, Part 2, pp. 115-119, 1921.
[2] A new group test by Herschel T. Manuel has appeared since the study was completed.
[3] Haggerty, M. E., *Hagerty Intelligence Examination*, World Book Co.
[4] Lowell, Frances, *A Group Scale of Intelligence for Primary Grades*, J. App. Psych., Vol. 3 pp. 215-247, 1919.
[5] Myers, Caroline E. and Garry C., *A Group Intelligence Test*, Sch. and Soc., Vol. 10, pp. 355-360, 1919.

(1919) Pressey Primer Scale [6]
Towne Picture-Game Test [7]
Detroit First Grade Test [8]
(1920) Holley Picture Completion Test [9]
(1920) Otis Group Intelligence Scale, Primary Examination Forms A and B [10]
Seattle Entrance Class Tests [11]
(1920) Smith Graded Intelligence Tests [12]
(1920) Dearborn Group Tests of Intelligence, Series 1 [13]
(1921) Johnson Non-Verbal 2 [14]
(1921) Cole-Vincent Group Intelligence Test for School Entrance [15]
(1921) Kingsbury Primary Group Intelligence Scale, Form A [16]

It has been very difficult to gather information of value about several of the examinations mentioned in this study. This was especially true in the case of statistical data. Because of this fact, the comparisons made in Table I are confined to material gathered largely from test booklets and from directions for giving and scoring. In this table the first column shows how widely different are the periods of time taken to give the tests, the extremes being 8 and 85 minutes. The next two columns contrast the actual material of which the examinations are composed. For this, the number of items is a better measure than the number of tests, as the latter differ enormously in length. The table also shows the tremendous influence of Binet in the choice of test material. The lack of fore-exercises in several instances is to be deplored, whereas the high objectivity in scoring is very encouraging, both from the standpoint of efficiency and reliability.

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[6] Pressy, Luella Winifred, *A Group Scale of Intelligence for Use in the First Three Grades*, J. Ed. Psych., Vol. 10, pp. 297-308, 1919; and J. Ed. Research, Vol. 1, pp. 285-294, 1920.

[7] Towne, Clara Harrison, *Towne Picture-Game Test*, Published by the Orthogenic Clinic, Public Schools, Kansas City, Mo.

[8] Engel, Anna M., *Detroit First-Grade Intelligence Test*, World Book Co.

[9] Holley, Charles E., *A Picture Completion Test*, described in *Mental Tests for School Use*, Univ. of Ill. Bulletin No. 28, Vol. 17, March 8, 1920.

[10] Otis, Arthur S., *Otis Group Intelligence Scale, Primary Examination*, World Book Co.

[11] *Seattle Entrance Class Tests*, Board of Education, Seattle, Wash.

[12] Smith, Franklin, O., *Graded Intelligence Tests*, University of Montana.

[13] Dearborn, W. F., *Dearborn Group Tests of Intelligence, Series* I. J. B Lippincott and Co.

[14] Johnson, O. J., *Non-Verbal 2 Intelligence Examination for Primary Pupils*, Dept. of Education, Public Schools, St. Paul, Minn.

[15] Cole L. W., and Vincent, Leona E., *Group Intelligence Tests for School Entrance*, State Normal School, Emporia, Kansas.

[16] Kingsbury, Forest A., *Kingsbury Primary Group Intelligence Scale*, Public School Publishing Co.

TABLE I

Giving Comparisons Between Primary Intelligence Examinations

Name of Examination	No. Min. to Give	No. Tests	Total No. of Items	No. New Tests Not in Other Exams	Tests Adapted from Binet	No. Tests Having Fore-Exercises	For What Grades Exam is Adapted	No. Tests Objectively Scored	No. Tests Requiring Charts To Give
Lowell	70	25	84	11	11	0	1-2-3	25	2
Myers Mental Measure	20	3	51	1	1	3	1-2-3	3	1
Pressey Primer Scale	25	4	100	0	1	4	1-2-3	4	0
Seattle	48	4	67	3	0	4	1 (low)	4	2
Towne	23	13	26	0	11	6	1 (low)	13	0
Haggerty Delta 1	30	6	119	2	3	6	1-2-3	5	0
Detroit	24	15	64	0	4	0	1	14	0
Holley	8	1	20	0	1	1	1-2-3	1	0
Otis	45	8	100	3	4	8	1-2-3	8	0
Smith	35	10	100	2	2	10	1-2-3-4	10	0
Dearborn	85	14	197	10	10	0	1-2-3	12	5
Non-Verbal 2	40	5	94	1	3	5	1-2-3	5	1
Cole-Vincent	40	8	46	1	2	4	1 (low)	6	2
Kingsbury	22	4	46	2	1	4	1-2-3	4	0
Average	37.5	7.8	79.5						

TABLE II

SHOWING NUMBER OF TIMES EACH KIND OF TEST APPEARS IN 14 PRIMARY EXAMINATIONS.

	Names of Tests	Frequencies		Names of Tests	Frequencies
1.	Oral Directions	11	27.	Mixed-up Sentences	1
2.	Picture Completion	10	28.	Word Classification	1
3.	Substitution	7	29.	Moral Judgment	1
4.	Classification of Pictures	6	30.	Identfying Eyes, Nose and Mouth	1
5.	Drawing Designs	5	31.	Recogntion of Sex	1
6.	Pictorial Identities	5	32.	Telling Time	1
7.	Tapping	4	33.	Body Attitude	1
8.	Length of Lines	4	34.	Naming Pictures	1
9.	Word Comparison	3	35.	"Dominoes"— Numerical Quantities	1
10.	Maze	3	36.	tation	1
11.	Formboard	3	37.	Cossing out Letters	1
12.	Absurdities	3	38.	Perception of Sound	1
13.	Geometrical Figures	3	39.	Number of Toes	1
14.	Counting Objects	3	40.	Tying Bow Knot	1
15.	Dot Pattern	2	41.	Writing from Dictation	1
16.	Spot Card	2	42.	Comprehension	1
17.	Color Naming	2	43.	Drinking Cup	1
18.	Asthetic Comparison	2	44.	Tapping Squares	1
19.	Color Form	2	45.	Alphabet Test	1
20.	Ball and Field	2	46.	Memory of Words	1
21.	Value of Stamps	2	47.	Opposites	1
22.	Picture Sequence	2	48.	Completion	1
23.	Pattern Completion	2			
24.	Pictorial Relations	2			
25.	Memory for Digits	2			
26.	Common Sense	1			

DISTRIBUTION OF TYPES OF TESTS IN PRIMARY EXAMINATIONS.

In Table II all tests have been classified into groups. One cannot fail being impressed by the large number of different kinds of exercises that have been devised to measure the intelligence of young children. It is interesting to note, also, the popularity of Oral Directions and Picture Completions. Of these tests, twelve

are directly adapted from the Binet-Simon Scale, or its revisions. Eight others are derived from the same source, but have been greatly modified. The remaining twenty-eight are drawn from group intelligence examinations for older persons, or have been invented as new tests.

Correlations With Binet

Table III gives the results, so far as it has been possible to ascertain them, of the correlations between various primary examinations and Binet mental ages. The differences in composition of the groups of pupils used in determining these relations make direct comparison of the coefficients a very difficult matter, but they are at least suggestive.

TABLE III

SHOWING CORRELATION OF PRIMARY EXAMINATIONS WITH BINET MENTAL AGES.[17]

Examination	r	No. and Kind of Cases
Haggerty Delta[18]	.74	27 (Public school)
Lowell	.76	76 (Public school)
Myers Mental Measure	.81 to .83	Less than 30 cases (Public school)
Pressey	.75	64 (Feeble-minded children)
Pressey	.66	148 (Public school)
Seattle[19]	.738	274 (Entering school)
Seattle	.447	97 (Entering school)
Dearborn[20]	.73	140 (Feeble-minded)
Dearborn	.81	88 (Public school)
Non-Verbal 2	.765	63 (Subnormal pupils)

Part II.

The Non-Verbal 2 Intelligence Examination for Primary Pupils.[21]

Selection and Construction of Tests.

The first work on the Examination was begun by the writer early in 1919. It consisted of a careful study of all non-verbal tests with a view of selecting such as could be readily adapted to young children. After discarding a number which proved undesir-

[17] These correlations are found in the articles previously referred to.
[18] Statistical computation done by Eleanor Bremer, Mental Hygiene Association, Philadelphia, Pa.
[19] Letter to writer Jan. 30, 1921.
[20] Letter to writer Feb. 11, 1921.
[21] This Examination is called Non-Verbal 2 to distinguish it from Non-Verbal 1 for kindergarten and first grade now in preparation.

able, the following were retained: Part Wholes, Maze, Number and Letter Checking, Geometrical Forms, Oral Directions, Designs, Substitution, Pictorial Completion, and Pictorial Identities. After repeated trials and revisions, it was necessary to discard the first four of these tests—the Part Wholes because it was verbal [23] and the others because of the difficulty of adapting them to first grade pupils. The last five were again revised and put into as usable form as possible. These are the tests of which the Non-Verbal 2 Examination is composed.

The method of selecting or rejecting items was as follows. All tests were given to about seventy first and second grade children. The papers were then arranged in the order of scores on all the tests combined. Each item was subjected to the following treatment: if more pupils standing above the median in all tests passed an item successfully than pupils standing below, the item was considered satisfactory in respect to significance, and if acceptable in other ways, was retained. In this manner, it was possible to eliminate items not discriminative of the kind of abilities measured by the whole examination. In addition to this, each item was also checked up against Stanford-Binet scores of sixty-five first grade pupils. In the case of a few doubtful items, the combined scores of all tests and Stanford-Binet mental ages were used for final disposition.

When all undesirable items had been thrown out, the remaining ones were arranged in order of difficulty, using the P.E. as a measure [24]. In a few instances where large gaps were found, other items of the desired difficulty were inserted in the required places, thus insuring a more even gradation from the easiest to the most difficult.

In order to give a more comprehensive idea of the kind of tests included in the Non-Verbal 2 Intelligence Examination, a brief description of each will be given below. This will be supplemented by comparisons with other tests in order to point out the main differences or similarities.

The Oral Directions Test.

This test differs from other tests in use mainly in regard to length. It contains sixteen items graded in difficulty and four others which are used as a fore-exercise. Great length is of importance in that it tends to increase reliability, thus making the scores of much greater value. For this reason and because an exercise of this sort serves to adapt pupils to the whole testing

[23] This test was used as a part of the criterion described farther on.
[24] The tables from which the P.E. values were calculated are given in Woody, Clifford, *Measurements of Some Achievements in Arithmetic*, Teachers Coll. Contrib. to Educ., No. 80, p. 37.

situation and particularly to the much longer uninterrupted working periods of the tests that follow, it was given first place in the examination.

Considered from one standpoint, directions tests fall into two distinct classes. Some items call for scarcely any specific knowledge of facts, while others verge on being tests of general information. A test like Abelson's "Geometric Figures" [24] is of the former kind and calls mainly for correct performance of the directions, while in the following example, there is needed specific knowledge of a particular kind: "If a captain is superior to a corporal, put a cross in the second circle." Here the stress is laid on the information.

In making up the material to go into the Oral Directions Test of the Non-Verbal 2 Examintion care was exercised that it should belong to neither of these two types. Some information of a practical nature is called for, but in most cases correct responses depend on the understanding, and ability to execute, the commands, with speed.

The Designs Test.

Designs tests also naturally divide themselves into two groups. In the first, the subject copies the design while looking at it; in the second, it is reproduced immediately after being observed. Both kinds of tests were used by Binet and Simon and have later been included in almost all revisions of their scale. But the majority of such exercises have one conspicuous disadvantage, namely, that the designs drawn by the children take multifarious shapes which are very hard to score. To remedy this defect, the figures used in Non-Verbal 2 have been so constructed as to be distinctively objective in scoring. By this plan the pupil must remember the design, but his response takes definite shape, because part of the figure is already on the paper. His work is to fill in the missing part. Such drawings can also be evaluated objectively by counting the missing lines which the pupil has supplied.

The Substitution Test.

It is likely that in the case of young children the most important abilities measured by this test are those involved in making the substitutions with speed rather than in the rapidity of learning the symbols. The time limit of three minutes is too short to permit any except the brightest pupils to learn the symbols, but experimentation seems to indicate that it is extremely difficult to secure maximum effort from primary pupils for a period longer than this. Most tests now used are far briefer and hence fall short of secur-

[24] Abelson, A. R., *Mental Ability of Backward Children*, Br. Jr. of Psych., Vol. 4, pp. 286-314, 1911.

ing an adequate indication of a child's ability. A unique feature of the exercises in the Non-Verbal 2 is the simplicity of the symbols. All of them, except one, can be made with one stroke of the pencil. Most symbols in other examinations require two or even three strokes and this unduly retards young children who have not yet developed adequate control over hand and arm muscles. By making the signs easy, it was believed that these defects could be minimized thus enhancing the value of the exercise. Its high reliability and significance as shown by statistical analysis bears out this hypothesis.

The Picture Completion Test.

Picture completions as found in tests may be divided into two groups. In the most common kind, a part of an object is missing. Here the matter is factual and successful performance depends to a considerable extent on acquaintance with the object represented. This becomes, then, virtually a test of general information. In the second kind, the picture represents a natural principle; i. e., two animals, one of which casts a shadow while the other one does not. The third kind of item is a symmetrical design, a part which has been left out.

The picture completion test in the Non-Verbal 2 Examination belongs to the first and third types. All items are either symmetrical designs, or pictures of objects with which children are, in general, familiar. It may be stated that the symmetrical design is a form of exercise, original with the author, which shows promise of usefulness.[25] The designs included in this test have proven excellent; they are easy to give and objective to score.

The Pictorial Identities Test.

This form of exercise is one of the latest to develop, and it appears to fill a unique place.[26] When one examines group tests for young children, one is struck with the fact that none appear to call for the higher types of thinking. They deal more with sensory abilities, perception, recognition of things, motor manipulation, and so on, rather than the more conceptual processes involved in abstract thinking. The predominance of the first mentioned kind of tests for primary pupils is undoubtedly proper, inasmuch as young children have not yet developed the higher thought activities and hence should not be given many tests measuring them. But these processes are not entirely absent even in early childhood and they seem to become more predominant

[25] This kind of item appears also in the Otis Primary Examination.

[26] This test was made up by selecting twenty items from the preliminary forms of Non-Verbal B published by the national Research Council. The Pictorial Identities Tests in these examinations were originally devised by Dr. M. E. Haggerty to be used in the Virginia School Survey. They are included in the Non-Verbal 2 Examination by his permission.

as children grow older. They also appear to be fundamental for human progress.[27] For these reasons, at least one such test ought to be included in an intelligence examination, and it seems that Pictorial Identities fills the place.

CRITERION OF INTELLIGENCE.

In order to determine how well an examination measures the traits it is supposed to measure, it is necessary to evaluate it in terms of some adequate criterion. This important procedure in test construction seems to have been neglected by many workers. It is a thing that cannot be determined offhand, but must be ascertained through rather laborious statistical methods. The early work in establishing criteria made almost exclusive use of ratings of pupils by their teachers and fellow students. For the final criterion, the separate judgments of several persons were averaged to form a more reliable measure. In recent years greater weight has been given to more objective data, such as composite scores on several kinds of tests, grade location, age, and scholarship of pupils as shown by teachers' marks.[28] By these methods more comprehensive evaluations of pupils' native mental capacities result, and they tend to be more valuable because they give less weight to non-intellectual traits.

The criterion against which the significance of the scores obtained by the use of the Non-Verbal 2 Eamination was evaluated is given below. It consists of the pooled results of the following five measures of pupils' mental abilities: the scores on two non-verbal intelligence examinations. two reading tests, and teachers ratings of intelligence. The ratings were given numerical values. All of these measures were then added together to form a composite whole and the correlations between it and the Non-Verbal 2 Examination were determined for each separate test and the Total Score. The criterion is given below:

CRITERION.

1. Haggerty Intelligence Examination, Delta 1.
2. Pressey Primer Scale (Scores times one-half.)
3. Haggerty Reading Examination, Sigma 1.
4. Part Wholes Test (Vocabulary)[29]
5. Teachers' Ratings, using these designations to which were assigned the accompanying number values: Excellent (16); Very Good (12); Good (8); Fair (4); Poor (0).

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[27] Terman, L., (32) *Intelligence and Its Measurement: A Symposium*, J. Ed. Psy., Vol. 12, pp. 127-133, 1921. (Article by L. M. Terman)

[28] See Haggerty, M. E., *Haggerty Intelligence Examination, Manual of Directions*, and Terman, L. M., *Terman Group Test of Mental Ability, Manual of Directions*, World Book Company.

[29] Mentioned at the beginning of this article. The test contains words selected from first and second grade readers in common use.

TABLE IV

Showing the Correlation of the Separate Tests and of the Total Score of the Non-Verbal 2 Examination with Criterion.

(101 pupils, grades 1 high to 3 high).

Tests	r	P.E.
Total Score (Present five Tests)	.841	.019
Oral Directions	.673	.020
Designs	.546	.046
Substitution	.739	.030
Pictorial Completion	.503	.049
Pictorial Identities	.636	.039
Geometrical Figures	.278	.061
Total Score, Six Tests	.822	.020

In Table V below the significance of the various combinations of tests has been calculated in a way believed to be original with the writer. The plan was to see if the cœfficients of correlation with the Criterion would increase or decrease when tests were omitted from the examination. The results show that the cœfficient decreases when any one of the first five tests are omitted, but that it increases when the Geometrical Figures test is left out. This indicates that all the tests but this one add elements which help to increase the correlation of the whole examination with the Criterion. As a result of this drop in the coefficient, the Geometrical Figures Test was left out.

TABLE V

Showing the Correlation with Criterion of the Six Tests First Included in the Non-Verbal 2 Examination. It Further Shows the Change in the Size of the Cœfficient Due to Leaving out Successively the scores of one of these tests. (101 pupils, grades 1 high to 3 high.)

Tests	r	P.E.
Total Score, Six Tests	.822	.020
These Six Tests, but		
1. Leaving out Oral Directions	.795	.024
2. Leaving out Designs	.807	.023
3. Leaving out Substitution	.777	.026
4. Leaving out Pict. Compl.	.810	.022
5. Leaving out Pict. Ident.	.797	.024
6. Leaving out Geom. Figures	.841	.019

Correlation With Stanford-Binet

Opportunity was found to give the tests to a group of 63 subnormal pupils who had previously been Bineted. These children ranged in mental age from 5 years 9 months to 13 years and had been examined during a period stretching back somewhat over two years. The correlation cœfficients are given in Table VI. They are not as high as one might at first expect. Due to the difficulty in giving group tests to subnormal pupils and because of the unreliability of the mental ages themselves, and the lapse of time, in many cases, since the individual tests were given, a high degree of correspondence between the scores can not be expected.

TABLE VI

Showng Correlation of Non-Verbal 2 Examination with Mental Ages (63 subnormal pupils).

Test	r	P.E.
Total Score (Present five tests).	.765	.035
Oral Directions	.625	.051
Designs	.473	.065
Substitutions	.743	.037
Pictorial Completion	.356	.073
Pictorial Identities	.610	.052

TABLE VII

Showing Correlation of Separate Tests of Non-Verbal 2 Examination with Mental Ages on the Stanford-Binet Scale (107 Cases, Grades 1 high to 3 high).

	r	P.E.
Oral Directions	.598	.040
Designs	.519	.046
Substitution	.706	.032
Pictorial Completion	.630	.038
Pictorial Identities	.757	.023

Intercorrelations.

The statement made in the preceding section that tests should correlate closely with the Total Score needs one qualification. It seems desirable only when intercorrelations between the tests themselves are low. If an exercise correlates high with the other tests, its close correlation with the Total Score would be due to its measuring the same abilities as the other tests. Low correlations on the other hand, indicate that the exercises, although meas-

uring essentially different functions, unite on the one point of testing the same traits as the examination itself.

Table VII reveals that the tests in Non-Verbal 2 measure esentially different mental functions. The last column gives the average of the intercorrelation cœfficient for each test and indicates how each is related to the other four. In no case is the relation close.

TABLE VIII

Showing Intercorrelations of Tests of Non-Verbal 2 Examination (107 Cases, Grade 1 high to 3 high).

Tests		Oral Direct.	Designs	Substitution	Pict. Comp.	Pict. Ident.	Average
Oral Directions	r		.195	.361	.272	.372	.300
	P.E.		.063	.056	.059	.055	
Designs	r	.195		.216	.225	.251	.219
	P.E.	.062		.061	.060	.059	
Substitution	r	.361	.216		.380	.357	.328
	P.E.	.056	.061		.054	.056	
Pictorial Completion	r	.272	.225	.380		.467	.336
	P.E.	.059	.060	.054		.050	
Pictorial Identities	r	.372	.241	.357	.467		.359
	P.E.	.055	.060	.056	.050		

Reliability of Tests.

The definition given by Burt is so comprehensive that it will be repeated here.[30] He says: "The amount of fluctuation to which a given mode of measurement is liable can be determined by finding the correlation between two sets of experimental figures obtained on different occasions or by different observers for one and the same measurement, or the average correlation if the measurement was applied more than twice. The cœfficient thus obtained is called the Reliability Cœfficient, and measures inversely the reduction of apparent correlation caused by errors of observation incidental to that measurement." This method has been used by several investigators, and there can be no doubt that it is of the greatest importance to every one who tries to devise new tests of any sort, even though it has certain limitations as recently pointed out by Kelley.[31]

In the case of the Non-Verbal 2, the tests were given to the pupils with an interval of one week. The medians of each test for the entire group were calculated for the two givings to deter-

[30] Burt, Cyril, *Experimental Tests of General Intelligence*, Br. Jr. Psych., Vol. 3, pp. 95-177, 1909.

[31] Kelley, Truman Lee, *Reliability of Tests*, J. Ed. Research, Vol. III, pp. 370-379, May 1921.

mine the amount of improvement. It was remarkable that out of the 107 pupils only one made a lower score the second time.

TABLE IX

Showing Median Improvement in Tests of NonVerbal 2 Examination. (107 Cases, Grades 1 high to 3 high)

	Median Score First Giving	Median Score SecondGiving	Improvement in per cent
Oral Directions	9	11	22
Designs	9	12	33
Substitutions	8	11	37
Pictorial Comp.	10	11	31
Pictorial Ident.	9	12	33
Total Score	44	54	24

It is contrary to popular opinion that so very constant results can be obtained in the examination of young children by the group method. The cœfficients in Table X prove that with proper care the group method is almost as adequate for primary grades as with the upper grades or in high school.

TABLE X

Giving Reliability Cœfficients of Non-Verbal 2 Examination. (107 Cases, Grades 1 high to 3 high)

	r	P.E.
Total Score	.832	.019
Oral Directions	.560	.044
Designs	.794	.023
Substitution	.707	.032
Pictorial Completion	.730	.030
Pictorial Identities	.802	.022

Correlation with Scholarship.

Scores in Non-Verbal 2, and of three other Intellience examinations were correlated with teacher's ratings of scholarship. These ratings were made by persons who had taught the children one semester or more. The scheme used was a five group classification using the designations: Excellent, Very Good, Fair, and Poor. The correlations of these tests with scholarship are almost as high as that found for the Army Examination Alpha in the case of high school students[32] and compare favorably with results of other studies among which may be named one made by Proctor.[33]

[32] Psychological Examining in United States Army, *Memoirs of the National Academy of Sciences*, Vol. XV. 1921.

[33] Procter, W. M., Psychological tests and the Probable School Success of High School Pupils, J. Ed. Research, Vol. 1, pp. 258-270, Apr. 1920.

TABLE XI

Showing Correlation with Scholarship. (71 Cases, Grade 1 high to 3 high)

	r	P.E.
Non-Verbal 2	.413	.065
Haggerty Delta 1	.419	.064
Pressy Primer Scale	.322	.071
Haggerty Sigma 1	.722	.039

It was worth while also to find the closeness of relation between Non-Verbal 2 and the three other examinations used in this study. The cœfficients in Table XI demonstrate that these tests do to a large degree measure the same abilities as Non-Verbal 2, this being especially true in the case of Delta 1. The closeness of the relation with the reading test Sigma 1 is also very interesting.

TABLE XII

Showing Correlation Between Primary Examinations. (71 Cases, Grades 1 high to 3 high)

	r	P.E.
Non-Verbal 2 and Delta 1	.726	.037
Non-Verbal 2 and Sigma 1	.695	.040
Non-Verbal 2 and Pressy	.616	.048

TENTATIVE STANDARDS.

The norms given below are derived from scores obtained in St. Paul, Minnesota. At present the examination is being given to pupils in cities and towns throughout several states in the Middle West, principally in Minnesota. When this testing is completed, representative norms will have been established for typical schools of the Middle West.

TABLE XIII

Giving Grade Medians, and Age Medians [84]

	1B	1A	2B	2A	3B	3A	7	8	9
Oral Directions	4	7	8	9	10	11	7	8	9
Designs	5	6	7	9	9	11	8	9	10
Substitution (Div. by 3)	3	7	9	10	11	16	7	10	11
Pictorial Comp.	6	8	9	9	10	9	9	9	10
Pictorial Ident.	2	5	8	9	10	10	6	9	10
Total Score	19	34	42	47	50	55	36	45	50
No. of Pupils	139	181	112	154	117	76	266	263	118

[84] Age 7 includes all pupils who are between 6 years 6 months and 7 years 5 months. Ages 8 and 9 were figured by the same method.

NEWS AND COMMENT.

In this section the editors will attempt to present in brief form any news concerning important movements in the field of Applied Psychology which are taking place in the world; also reviews of the results of significant investigations in the field not published in the Journal. Brief and terse reports from contributing editors and others bearing on these points will therefore be gladly received and published so far as their merit and space will permit. We are particularly desirous of keeping our readers informed in regard to the more important developments in this field.

New Bureau of Personnel Administration

To study and formulate the best methods of selection, transfer and promotion of public service employees is the primary function of the newly-organized Bureau of Personnel Administration at Washington, D. C. Professor L. L. Thurstone, head of the Department of Education and Psychology at Carnegie Institute of Technology, Pittsburgh, has been appointed Director of Research in charge of the Bureau, effective January 1st, 1923.

The Bureau is to be affiliated with the Institute of Government Research, and has been privately endowed subsequent to appeals for its establishment from the United States Civil Service Commission. An advisory board of five members of the national civil service commissions will supervise the operation of the bureau.

Mr. Thurstone and his associates will immediately take up the study of the selection, transfer and promotion on a basis of merit of all public service employees: classification of the positions in public service; methods of rating efficiency; reorganization of training courses for federal employes; recommendation of postal clerk and carrier tests; organization and procedure of district offices of the Civil Service Commission; and various other personnel problems outlined by the advisory board. Its field of work covers investigations of state and municipal employee problems in addition to those of the federal service.

SECOND INTERNATIONAL CONFERENCE OF PSYCHO-TECHNICS[1] APPLIED TO VOCATIONAL GUIDANCE AND TO SCIENTIFIC MANAGEMENT.

By Harry D. Kitson
Indiana University

European psychologists have made two correlations that American psychologists have not yet sufficiently established: (1) that between their science and scientific management; (2) that between the psychological problems of scientific management and those of vocational guidance. European psychologists see these relations clearly, as is evidenced by the fact that they have for three years held annual international conferences for the application of psychology to these two fields.

The first of these conferences was held at Geneva in 1920, the second at Barcelona in 1921, and the third at Milan, in 1922. The complete report of the second is now in the hands of the writer, and in fulfillment of a promise made in a previous number of this Journal, a resume of the proceedings is herewith presented.[2]

The conference was organized in three sections corresponding to the three main topics of discussion:

Section I. Vocational Selection and Study of Work.

A. **Vocational selection:** General methods of research in psychotechnics applied to vocational selection. Inventory of the vocations already studied by psycho-technicians, examination of their results with a view to their application in vocational guidance. Program of international investigation in the determination of aptitudes required by certain vocations. Agreement upon a method for the investigation of the most important function in common occupations: motor aptitudes, attention, memory, etc., to the end of obtaining comparable results. Some special psychotechnical facts: Monotony, visual defects, tapping test.

B. Researches on the adaptation of movements to vocational ends.

[1] Psycho- technics, it will be remembered, is the term employed by Muensterberg (Psychology and Industrial Efficiency, Boston. Houghton Mifflin Co., 1913, p. 17) to denote the application of experimental psychology in economic fields. It is widely used in Europe.

[2] The papers are published as delivered in the original languages, by *L'Institut D'Orientacio Professional*, Barcelona, Sant Honorat, 5.

C. Study of vocational fatigue.

Methods for the discovery of objective signs of physical and mental fatigue.

Fatigue and Wages.

Fatigueability and Vocational Usefulness.

Section II. Vocational Guidance in General.

The scientific nature and the essential functions of Vocational Guidance.

What information should be called for on the medical, pedagogical and economic record blanks of the child?

How should these facts be secured; how used?

The problem of moral aptitudes.

Section III. Psychotechnics applied to vocational guidance.

What tests should be employed for the psychophysiological examination of those being guided?

What scientific facts are available for a classification of jobs according to the aptitudes which they demand of workers?

How can one evalute the results of the mental examination?

It is manifestly impossible to present here a complete report of the discussions, but an idea of their nature may be secured from a list of the forty-six papers read. A star preceding a topic indicates that the delegate was present and read his paper in person.

*The Service of the School in the Determination of Aptitudes, by Otto Lipmann, director of Institute of Applied Psychology, Berlin.

*Contribution of the School in the Investigation of Aptitudes, How to Obtain Them and How to Utilize Them, by J. Ruiz Castella, director of Institute of Vocational Guidance, Barcelona.

*Some Results of Vocational Psychotechnic, by Walter Moede, professor at the Technische Hochschule, Charlottenburg, Berlin.

*The Principal Problems of Vocational Guidance, by Claparede, University of Geneva.

*Motor Tests in Vocational Guidance, by A. G. Christiaens, Director of the Inter-Communal Bureau of Vocational Guidance, Brussels.

*Tests of Aptitude in Drawing and their Application in Vocational Guidance, by O. Decroly, professor of Child Psychology in the Free University of Brussels.

*Psychological Automatism and Vocational Guidance, by Geo. Dwelshauvers, Professor of Normal Studies and Director of Laboratory of Experimental Psychology, Barcelona.

The Role of Rhythm in Vocational Work, by M. J. Waldsburger, collaborator in the Laboratory of Experimental Psychology, Ecole Pratique des Hautes Etudes, Paris.

*The Application of Physiology to the Arrangement of Work, by Marcel Frois, Professor of Hygiene, Institut Lannelongne d'Hygiene Sociale, Paris.

The Economy of Human Effort in Industry, by Eric Farmer, Investigator to the Industrial Fatigue Research Board, London.

*Vocational Guidance for Industrial Occupations, by Geo. H Miles, D. Sc., Secretary of the National Institute of Industrial Psychology, London.

The Investigation of the Motor Function, by Raymond Buyse Il. pecor of Primary Education, Saint Gilles, Belgium.

Two Communications from the International Bureau of Labor: 1. The Scientific Selection of Personnel in the United States of America. 2. The International Bureau of Labor and Vocational Guidance.

Scientific Management and Mental Hygiene, by Genil Perrin, head of the clinic of mental disease in the School of Medicine of Paris, General Secretary of the Mental Hygiene Association of France.

A Few Suggestions, by A. Imbert, Honorary Professor in the School of Medi-

eine, Montpelier; Professor of the Physiology of Work in the School of Medicine Marseilles.

*The School, the Laboratory, the Factory and the Development of Manual Skill, by J. M. Laby, of the Laboratory of Experimental Psychology of the Sorbonne, and of the Association of Mental Hygiene, Paris.

Synopsis of Investigation on Vocational Ability in Engineering Trades, by Max Tagg, Department of Engineering, Acton & Chiswick Polytechnic, Bedford Park, London.

*Some Socio-Economic Aspects of Scientific Management, by J. M. Tallada, Engineer, member of the Advisory Council of the Institute of Vocational Guidance, Barcelona.

*The Medico-Anthropometric Record Blank, by L. Trias de Bes, head of the Medico-Anthropometric Laboratory of the Vocational Guidance Institute, Barcelona.

*Uses of Medical Measurements in the Vocational Guidance Institute, by J. M. Lucena, Assistant in the Medico-Anthropometric laboratory of the Vocational Guidance Institute, Barcelona.

*Immediate Organization of the Vocational Guidance of Youth, by E. Gauthier head of the Office Regional de la Main d'Oeuvre du Ministere de Travail de France, Paris.

How to Make Vocational Guidance Scientific, by Richard Liebenberg, Employment Director of the City of Berlin.

*Vocational Guidance for Deaf Mutes, by P. Barnils, Director of the School for Deaf and Mutes, Vilajoana (Spain.)

Psychotechnic in Italy, by G. C. Ferrari, Bologna.

Establishment of Vocational Guidance Offices by F. Mauvezin, Director, Chambre de Metiers of the Gironde and of the South-West Bordeaux.

The Berlin "Classes for Gifted Children" After Four Years Trial, by Kurt Piorkowski, Director of the Orga-Institut, Berlin.

*Vocational Guidance as Practiced at the Institut, Emil Metz, by Aloyse Robert, of the Institut Emil Metz, Dommeldange (Luxemburg).

*Essentials of Vocational Guidance, by J. Ruiz-Castella, Director of the Institute of Vocational Guidance, Barcelona.

*Scientific Relations Between the Medical Inspection in Schools and the Institute of Vocational Guidance, by Manuel Salvat Espasa, Medical Inspector of Schools, Barcelona.

Necessity of a Practical Method of Vocational Guidance, by R. Thery, head of vocational guidance office at Nantes.

*The Participation of the Placement Office of the Department of the Seine in the Work of Vocational Guidance, by A. Touzas, Bureau of Labor Statistics of the Seine, Paris.

*A Test of 'Sympathetic Intuition" for the Examination of Moral Aptitudes, by Franziska Baumgarten, Berlin.

*Cario-Vascular Accompaniments of Mental Work, by E. Mira, head of the Psycho-Technic Laboratory of the Vocational Guidance Institute, Barcelona.

*The Psycho-Physiological Examination in the Interest of Education and Vocational Guidance, by N. Braunhausen, Professor of Experimental Psychology, Lycee of Luxembourg.

*The Psycho-Galvanic Phenomenon in Psycho-Technics, by J. M. Bellido, Assistant Director of the Institute of Physiology, Barcelona

General Ability and the Objective Psychic Function, by Julius de Boer, of Nimegue (Holland).

English Contributions to the Study of Mental Tests, by Cyril Burt, Psychologist to the London County Council.

*The Measurement of the Intelligence of School Children in Barcelona, by Llorens Cabos, Principal of the National Schools of Barcelona.

The Intelligence Aspect of Arithmetic, by D. J. Collar, London.

The Place of the Psychologist in Industry, by Frank B. and Lillian M. Gilbreth, Montclair, New Jersey, U. S. A.

*Psychotechnical Study of Watchmaking, by Hugo Heinis, Laboratory of Psychotechnics of the University of Geneva.

The Determination of Vocational Aptitude, by A. Imbert, Professor of the Physiology of Work at the School of Medicine, Marseilles.

*The Binet Tests and the American Revision, by J. M Lahy, and A. Fessard, Paris.

*Education and Adaptability, by J. M. Lucena, Assistant in the Psychometric Laboratory of the Vocational Guidance Institute, Barcelona.

*Tests for Bridgebuilders, by Aloyse Robert, of theInstitut Emile Metz, Dommeldange, (Luxenbourg.)

*The Relation Between Concentrated Attention and the Extent of the Visual Fie'd, by C. Soler Dopff, Assistant at the Psychometric laboratory, Vocational Guidance Institute, Barcelona.

*Psychotechnical Methods employed in the Laboratory of the City of Amsterdam, by G. van Wayenburg, Privat-Docent of Psychology and Paidology, University of Amsterdam.

Questions that were treated in extended discussion are: Shall the schools assume chief responsibility for vocational guidance?

At what age shall formal guidance begin? Shall the guidance be continuous, as proposed by some in the United States, or shall it be given once for all? How many times shall tests be given for the determination of aptitude? After warm discussion of these questions in sectional and general conference, a series of conclusions and recommendations were adopted as representing the view of the majority of the delegates:

I. Regarding the practice of vocational guidance:

1. Vocational guidance in its scientific aspect is an economic and a social problem. In consequence, it cannot be narrowed down merely to a function of the schools; it must be attached to bureaus of placement and institutions insuring against unemployment.

2. A single examination of a child can give only approximate indications in a certain number of cases, and for a certain number of aptitudes; it would be desirable to extend this examination over a period of time before the child leaves school, and while he is in the first stages of apprenticeship. The special conditions of each bureau of vocational guidance should determine the extent of these examinations.

3. To the end of perfecting methods, the results which have already been obtained by persons who have been placed in industry should be studied scientifically, from the following points of view: technical progress, interest in work, fatigueability, and wages.

4. The medical record should be standardized and should contain two parts:

a. One page containing observations of an anthropometric and physiopathological sort. This must be regarded as confidential.

b. A record to be filed with the bureau of vocational guidance showing individual data which will permit the investigation of a group of occupations.

II. Regarding Methods of Increasing Industrial Efficiency:

1. Public agencies should favor physiological and psychological researches looking toward the establishment of scientific management and vocational guidance upon a scientific basis.

2. The conference recommends that governments subsidize laboratories working upon the standardization of tests of vocational aptitude, and that the results of the investigation in the laboratories of the different countries be combined.

3. In the light of numerous sociological and physiological data it is recommended that eight hours of effective work be considered as a normal working day in the majority of industrial occupations.

4. The conference recommends that among the agencies of transportation (railroads, street cars, automobiles, steam ships) workers shall not be hired except upon psychological examination for vocational aptitude. Psychiatric control should also be exercised over such workers.

5. It is desirable to define more accurately such terms as: practical intelligence, mechanical aptitude, higher, medium and lower occupations; acquired, formal and material aptitudes.

One of the significant features on the program was the voice of the International Bureau of Labor, which appeared twice, once with an assurance of its moral support; again, with a statement regarding the administration of employment management in American industrial establishments. The Bureau, established in connection with the League of Nations, and with headquarters at Geneva, is deeply interested in vocational guidance. Its pronouncement at this conference was so significant that it is herewith translated in full:

"The International Bureau of Labor and Vocational Guidance."

"Vocational guidance is a problem that interests directly the activity of the International Bureau of Labor because it constitutes one of the primary conditions for the realization of the program of reforms set forth in the preamble of Part XIII of the treaty of Versailles. It may be considered as the basis of practically all the measures prescribed in the treaty of peace for the amelioration of the conditions of work and for the realization of social justice, which must form the bases of universal peace.

Specifically, it plays a capital role in 'the organization of technical and vocational instruction,' because it has for its purpose the selection of the well-endowed. It is the condition of 'rational recruitment of labor', because it seeks to determine exactly the aptitudes of each one. It furnishes the worker with a weapon in his 'battle against unemployment', because it increases his technical value. It aids in assuring him a 'living wage' because it raises his earning capacity to a maximum. It constitutes a 'protection to workers against general or occupational diseases and against industrial accidents, because it tends to give each one a job that accords with his physical capacities. It is a measure of 'protection for children and adolescents', because on the one hand it has for its purpose to guide them at the threshold of life; and on the other, to determine 'the conditions necessary for the extension of their education and for the development of their physique,' it has an important bearing upon 'the protection of women' because it takes account of the physical and moral factors involved in women's work. It plays a part in that which concerns the disbled veterans, because it is at the basis of vocational re-education, the results of which will serve to determine the degree of in-

capacity of the *mutilé*. It can contribute to the 'defense of workers employed in foreign lands' because the phenomenon of emigration requires a scientific study of the ethnic elements whose influence from a vocational point of view is clearly important. Finally, having for its ideal the realization for each individual of the occupation which best suits his aptitudes and his tastes, and which procures for him the deepest and most lasting satisfactions, vocational guidance appears to be that condition of 'moral and intellectual well-being of wage-earners', recognized by the signatory powers of the Treaty of Peace as being 'of primary importance from an international point of view'. Accordingly, the analysis of capacities is the foundation of a scientific organization of work and of an amelioration of the conditions of work.

The International Bureau of Labor, whose functions comprize the centralization and distribution of facts concerning the international standards of working conditions, has, since its inception, devoted special attention to the question of vocational guidance It has already organized services of emigration, of unemployment, and of industrial hygiene, in all of which it has recognized the important part played by vocational guidance. Similarly, in its efforts on behalf of those disabled in the war and in industry, it has been obliged to consider vocational guidance, notably in an article devoted to the vocational re-education of veterans in Great Britain. If the International Bureau of Labor has not been able heretofore to realize the establishment of a technical service devoted exclusively to the study of questions relative to education and apprenticeship, it has nevertheless charged one of its collaborators with the duty of centralizing all facts relating to these questions, of following their developments, and of maintaining contact with the measures taken or the experiments tried in the different countries.

The information service of the bureau takes great pains to collate from different journals and periodicals all facts bearing upon this question. A special category is devoted to technical education in the 'Facts of the Day' published bi-weekly. In addition, the Bureau proposes to publish in the 'International Labor Review' special articles upon vocational guidance written by specialists who have promised their cooperation.

Animated by the desire to follow as closely as possible the development of vocational guidance and cognate problems, the Bureau is constantly enlarging its library so as to include the most important works upon the question. It announces regularly in its 'bibliographical notes' recent publications on vocational education. In addition, it publishes in the International Labor Review bibliographical notices of publications pertaining to the general subject.

Finally, it has already entered into relation with such organizations as The Taylor Society of the United States the Industrial Fatigue Board of Great Britain, and the *Cours d'Orientation Professionnelle de France*, as well as with individuals who are devoting their attention to the problems of vocational guidance. The department of public instruction of the canton of Geneva, in particular, has willingly placed at its disposal results of valuable experiments carried on in cantons of Switzerland.

The International Bureau of Labor followed with the greatest interest the deliberations of the first international conference of psycho-technics applied to vocational guidance, which was held at Geneva in 1920, under the presidency of Professor Claparède; and M. Albert Thomas, in greeting the delegates who came to visit the International Bureau of Labor, assured them warmly that he considered their contributions most important for the realization of the tasks which the bureau has undertaken.

Desirious of neglecting no aspect of the task before it, and convinced of the immense importance that vocational guidance will assume in the scientific organization of work, the International Bureau of Labor will be particularly happy to follow the deliberations and to heed the counsels of the Second International Conference of Psycho-technics Applied to Vocational Guidance and Scientific Management."

The rule that delegate representation in the International Bureau of Labor is contingent upon membership in the League of Nations, does not at all bar American psychologists who are applying their science in the field of labor problems, from associating themselves with the scientific movements sponsored by the Bureau. They are cordially urged to read the publication of the Bureau—the International Labor Review—and to send reports of their investigations to the office of the psycho-technical representative of the Bureau—the Institute J. J. Rosseau, Geneva.

Space forbids detailed treatment of the other important events of the conference. The evidence here presented is sufficient, however, to show that European psychologists are seeing clearly the close relations that exist between psychology and scientific management and between the latter and vocational guidance, and that they are seriously attacking the salient problems in both fields.

PROGRAM AND WORK OF THE AMERICAN NATIONAL VOCATIONAL GUIDANCE ASSOCIATION.

The National Vocational Guidance Association of the United States of America met in annual convention at Detroit, Michigan, U. S. A., December 1 and 2. This organization has a special Section on Vocational Placement, on Vocational Guidance in the High School. A General and a Psychological Section. At the Psychological Section papers were presented on the following subjects:

1. Relations of Mental Levels to Industrial Life, by Helen T. Woolley, Assistant Director of the Merrill-Palmer School, Detroit.
2. An Investigation of the Vocational Changes of a Thousand Eminent Men, by Harry D. Kitson, Professor of Psychology, Indiana University.
3. The Use of Mental Tests in Educational and Vocational Guidance in fourteen Cities, by Mary Hays, Childrens Bureau, Washington, D. C.
4. Principles in Technique of Vocational Guidance found by the Institute of Educational Research, by Herbert A. Toops, Columbia University.
5. An Experiment in Educational Guidance, by Ruth Clark, Vocational Service for Juniors, New York City.

The Association voted to enter into collaboration with the Vocation Guidance Bureau of Harvard University in the publication of the official Bulletin of the Association. The officers of the Association for the coming year are Harry D. Kitson, Indiana University, President; John Brewer, Harvard University, secretary, and Arthur F. Payne, Harvard University, Treasurer.

MENTAL GROWTH CURVE OF NORMAL AND SUPERIOR CHILDREN STUDIED BY MEANS OF CONSECUTIVE INTELLIGENCE EXAMINATIONS.

This study, made by B. J. Baldwin and Lorle I. Stecher, and published in the University of Iowa Studies in Child Welfare, as Vol. II, No. 1, January, 1922. Pp. I-61, is the first serious effort to determine the nature of the mental growth curve of superior children as compared with that of average children by Binet tests repeated on the same children through a number of years. 143 children figure in the study, and 485 separate examinations were made, by four different examiners. The I. Q.'s ranged roughly from 90 to 160. The initial examinations were made at the Iowa Child Welfare Research Station in 1917. The time intervals between successive examinations varied from a few months to over two years, and the number of examinations per child varied from two to five. Terman's revision of the tests were used throughout.

The results are presented under three main headings: (1) the mental growth curve; (2) the possibility of prediction of mental growth; (3) the relation between physical and mental growth. As the examinations did not occur on or near the birthdays of the children, the mental ages for the exact chronological ages of 5, 6, 7, etc., were computed on the basis of the rate of mental progress between successive examinations. To get the mental growth curve these resultant mental ages were averaged for each chronological age from 5 to 14. The results are given separately throughout for boys and girls, and for the two grades of intelligence as given by the I. Q., termed "average" and superior." I. Q.'s for the average ranged from 90 to 110, and for the superior 111 and

over. The main conclusions reached from this first part of the study are (1) that the mental growth curves of average and superior children diverge, the difference in mental age between the two classes increasing with age; (2) that there is a significant change in the trend of the curve on approach to adolescence, and that an adolescent superiority of girls is also revealed; (3) that the general prepubertal increase appears earlier in the superior children; (4) that the I. Q. curves are approximately horizontal, and the I. Q. is constant within limitations; (5) that the increase in the mean I. Q. with an increase in age that was found is probably an effect of a greater habituation or practice in passing the tests.

Considerable variation in successive I. Q.'s of the same child were found frequently, leading the authors to give the caution that "extreme care should be exercised about making any dogmatic statements in regard to what a child's future status will be." The deviation of each child's I. Q. on each particular examination from his average I. Q. for all his examinations was computed. The mean I. Q .deviations from these averages were $4.48 \pm .53$ for superior boys, $6.92 \pm .78$ for superior girls, $2.65 \pm .23$ for average boys, and $3.80 \pm .29$ for average girls. The frequency of positive changes in the I. Q., that is, increases, is greater than the negative changes. This preponderance of positive changes is more marked for superior than for average children. Pearson co-efficients of correlation between the I. Q.'s of successive examinations range from $+.69 \pm .05$, in the case of the first and third examinations, to $+93 \pm .02$, in the case of the third and fourth examinations. There is no tendency for the correlation to decrease with increase in the interval between examinations. The more important conclusions summarized for this second section of the results are as follows: (1) There is a tendency for girls to vary more than boys, for superior to vary more than average children, and for older to vary more than younger. (2) between the first and second examinations most cases show an I. Q. change of less than five points; between the first and later examinations more cases show larger changes, with the increases in I. Q. becoming more numerous. (3) The greater tendency for superior children to show increases in I. Q. on later examinations, as compared with average children, is probably due to the former profiting more readily by practice. (4) "No final determination can be made of the effect of chronological age or of the interval between examinations on the change in I. Q.'s."

Height and weight measurements were made, also X-ray photos of the carpal bones. The mean mental age of the physiologically accellerated children was found uniformly higher than that of the

physiologically retarded. Correlations found were as follows: Height and mental age, boys $+.84\pm.02$, for girls $+.89\pm.02$. Weight and mental age, boys, $+.86\pm.02$, girls, $+.77\pm.04$. Mental age and X-ray result (exposed area of carpal bones of right wrist), boys, $+.87\pm.02$, girls, $+.87\pm.02$.

In their general conclusion the authors note that "the use of the Stanford Revision of the Binet scale even for the relatively short period of four years shows the unsuitability of this scale in its present form as a means for measuring mental growth. The limited number of alternative tests results in a certain practice effect on repeated examinations. Another defect of the present system of tests is in the lack of a sufficient number of tests at the higher levels to measure the mental growth that apparently goes on in a bright young child even after the exhaustion of the 16 or 18 year old tests."

Their conclusion that the results do not decide the question of a general tendency of the I. Q. of superior children to change with increasing age, because of the inadequacy of the tests is disappointing. The reviewer believes that this conclusion is, in part, the result of an error in the method of treating the data, and, in part, to their failure to consider other interpretations that explain more of the facts as we now have them. They are undoubtedly correct in attributing some of the gain in I. Q. with increasing age to practice effect. They are dealing largely with the upper levels of the scale where the tests are most affected by this fault. It is probable also that a small University town, with the children figuring in the study coming from the University school, and their parents undoubtedly more informed about the tests than would have been true of any other group, resulted in an unusual amount of coaching in the tests. But that this can explain all the increase in I. Q. that the results really show is highly improbable. Since they make it the sole explanation of one of the most important parts of the study, it seems that they might have made a greater effort to treat the results in a way that would support this explanation. But little attempt is made to do this. Their method of treating the results does not show the amount of increase in I. Q. with increasing age, but assumes a constancy of the I. Q. in the first place. The children are divided at each age into two classes, those below an I. Q. of 111 the average, and those above an I. Q. of 110, the superior. For each class the mean mental age, with I. Q. derived from this, was then computed at each age. If the I. Q. did increase with age, then obviously many of the older children classed as superior would have classed as average when younger, and many of the younger children now classed as average

would have been classed as superior later. This results in a raising of the mean I. Q. for the younger children and a lowering of the mean I. Q. for the older children. The authors give the raw data, including age, M. A. and I. Q. of each child at each examination. By summing up all the age intervals between examinations and also the I. Q. changes, irrespecitve of age, the reviewer finds the following general tendency of the I. Q. to increase with age Average yearly gain for superior boys, 3.89 points, for superior girls, 3.92 points, for average boys and girls together .45 points. Of those classes as average, 37 had I. Q.'s above 100, and 15 had I. Q.'s below 100. The class in which a child belongs, in each case, is determined by his average I. Q. for the two to five examinations given him. This gives an entirely different aspect to the results on this point. The author's analysis shows a slight increase; this reveals a very marked increase.

In my results on the re-examination of subnormal children, which showed a decrease in I. Q. with age, I attributed this fact to a decreasing rate with age of mental development of normal children, when this development is measured in terms of absolute, real units of development, and I anticipated that the I. Q. of superior children would for the same reason increase with age and explained how this would come about. (See Journal Applied Psychology, September, 1921). The present Iowa results on this point seem to me chiefly an empirical proof of this deduction.

Director State Research Bureau
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DR. F. KUHLMANN.

BOOK REVIEWS.

ALBERT S. OSBORN. *The Problem of Proof.* Matthew Bender Bender & Company, New York, 1922, pp. 526, Introduction by Professor J. H. Wigmore.

Osborn—whose *questioned documents* is the classic volume on the handling of disputed writing with the aid of modern instruments and in the light of scientific analysis—in his new book *The Problem of Proof,* considers the manner in which facts should be collected in preparation for a trial in which identification of handwriting or typewriting is concerned and how the evidence obtained should be presented. Trial lawyers, handwriting experts, and judges should read the book with care. Much practical and very valuable advice is given as to how to obtain writing standards with which to compare disputed material, how writing exhibits should be handled and filed and how shown in court. The attitude that the expert should assume while on the witness stand is discussed at length. A most interesting series of outlines to be used in the cross examination of incompetent and corrupt witnesses is given. And there are some candid comments on the designing and lighting of court rooms and hold-overs in court procedure that should be pondered by all those who occupy positions of authority in the legal realm.

All students concerned with problems of handwriting should know Osborn's work. For the general psychologist, in the particular book under consideration, the chapter on "Form Blindness or Defects of Sight in Relation to the Problem of Proof" is of most interest. It is a revised statement of an article published some years since by Osborn and cites experiments to show that something called form-blindness operates to a high degree in many observers and makes it very difficult for them to pass accurate judgements on writing or to identify hands except when greatly enlarged.

The psychologist should also profit by the discussion of handwriting recognition and identification by the untrained man and the analysis of what "knowing a hand" really means. There are problems raised that should be carried into the laboratory. The clear-cut description of the characteristics of natural writing and of the inherent evidences of genuineness or the reverse are important. The practical psychologist will read with interest the chapter on persuasion and the student of applied psychology find advice as to the course to follow in analysis of anonymous letters and in attempts to identify the writers of them.

University of Wyoming JUNE E. DOWNEY

GUY THOMAS BUSWELL, *Fundamental Reading Habits;* A Study of Their Development; Supplementary Educational Monograph No. 21, Chicago, Department of Education, The University of Chicago, 1922, pp. 14+150. $1.50.

The purpose of this study is to detect the fundamental reading habits of children and to compare them with the mature reading habits of adults. The assumption of the author is that by knowing what the child's early reading habits are to begin with, and what the mature habits of good readers are as an end product, we shall be better able to direct the child toward the desired goal of efficient reading. By knowing the route and the individual difficulties to be met the teacher is enabled to adapt the plan to the need.

Since all satisfactory methods of studying reading habits must rest on either a direct or an indirect measurement of some aspect of the reading process, the author has selected photographic reproductions of eye movements as the most objective in character, and the least subjective in judgment. The apparatus used was an improved type of that used by Dr. C. T. Gray in his studies in 1917. Dictaphone records were taken alongside the photographic reproductions of eye movements and thus a most thorough comparison of the two sets of data is made possible.

The study analyzes the reading of 187 different subjects ranging from children in grade I-B of the elementary school to adult college students. Frequent tables and charts show the relative stages of development for many of the characteristic reading habits. Probably the most striking feature of the data shown is the clearly demonstrated importance of the first four years of reading upon the development of mature reading habits. Another marked change in reading habits occurs in the early years in High School. The growth curves are very much alike for both oral and silent reading, though silent reading develops maturity in reading habits slightly faster than oral reading.

Dr. Buswell devotes about one third of his monograph to a detailed analysis of first grade reading. The children studied came from two different groups each of which had been taught by a radically different method. The analysis brings out the fundamental weaknesses of each method. The data is presented in exceptionally complete form and includes charts showing the number and extent of eye movements, the time of each fixation, the dictaphone reproductions of the reading, and the rhythmic expression of the subject while reading. This part of the monograph should prove especially valuable to teachers in that it will enable them to make a better analysis of the fundamentals of the methods they are employing, and should assist them greatly in placing a truer evaluation upon their own work. The latter third of the book is concerned with individual variations in reading habits and with the results of specific training. Characteristic cases from the 2nd, 3rd, 4th and 5th grades, and from High School and College are described and analyzed.

It is not assumed that a study of eye movements alone will make posible a complete diagnosis of all reading difficulties, but the author insists that such study must be a part of every complete study of reading defects. It reveals many specific difficulties which demand specific treatment. Dr. Buswell is not in agreement with those who insist that no artificial devices shall be allowed a place

with remedial teaching because they may lack social values, or permanent purpose outside the schoolroom. He urges the use of any kind of artificial device which by its temporary use will remedy the child's reading defect or bring him back to normal more rapidly than by some les direct method. For training the child in correct habits of eye movement an exposure apparatus to be used in conjunction with the stereopticon is described. How successful this device may be is neither demonstrated nor forecasted; but, being neither too intricate in structure nor over expensive in manufacture, it should find a place in any laboratory devoted to experimental work in reading.

Ohio University C. H. Growdon.

WILLIAM SCOTT GRAY, *Remedial Cases in Reading*: Their Diagnosis and Treatment—University of Chicago, 1922, Pp.vii-208. $1.75.

The content of this monograph is well described by its title. It promises to be a very suggestive and helpful volume for superintendents, principals, supervisors, and teachers—whether regular or special. In these days of fequent measurements of all kinds there is sometimes a tendency to make hasty diagnosis. This monograph shows the need for very careful and definite study of each case before final diagnosis is made; it gives detailed information as to existing defects in each case, and describes the procedure which was followed in the attempt to remedy each defect.

The author holds that diagnosis of one's reading defects is insufficient evidence upon which to base treatment. The causes must be determined. Among the more common fundamental causes of defective reading are listed: inferior intelligence, congenital word blindness, poor auditory memory, defective vision, narrow span of recognition, ineffective eye movements, inadequate training in phonetics, inadequate attention to content, inadequate speaking and meaning vocabularies, speech defects, lack of interest, guessing, and timidity.

Five chapters of the book (150 pages) are devoted to a detailed report of 26 cases which came under the observation of the author or his immediate assistants. These cases are grouped into five typical classes as follows: (a) pupils who had made little or no progress in reading, (b) pupils who had encountered serious difficulties in interpretation, (c) pupils who encountered difficulties primarily in the mechanics of reading, (d) pupils who encountered difficulties in the rate of silent reading, and (e) pupils who had made progress in reading but were weak in practically all phases of reading. The latter chapter of the work deals with the organization of diagnostic work in the city of Toledo, Ohio.

The book neither attempts to cover all types of reading defects nor does it dogmatize on the remedial treatments to be applied. It is merely a plain statement of a considerable number of typical cases with a description of the remedial measures attempted, and with an attempt to evaluate the efficiency of the methods used. As a source of helpful suggestions for those who must handle reading defects it is worthy of a careful reading. We believe that the stimulus it will give toward the organization of groups interested in the study and treatment of reading defects, and the encouragement it gives to teachers who daily face reading difficulties make its appearance especially timely.

Ohio University C. H. Growdon.

JOHN DEWEY, *Human Nature and Conduct.* New York, HENRY HOLT AND COMPANY, 1922.—pp. 336.

This late book from the facile pen of Professor Dewey gives to his many readers in his usual fresh and lucid style a constructive treatment of the primary facts of social psychology. It is the result of the re-writing and expansion of three lectures delivered by its author in Leland Stanford Junior University in the spring of 1918. While not purporting to be a treatment of social psychology, it nevertheless makes habit the central fact for the explanation of all social phenomena and seriously maintains that an understanding of habit is the key to social psychology.

The work is conveniently arranged in four parts as follows: First, The Place of Habit in Conduct; second, The Place of Impulse in Conduct; Third, The Place of Intelligence in Conduct; fourth Conclusion. Its fundamental premise is that all nature, including man and society, is continuous. Human conduct is explained as the result of the interaction between the instinctive elements in man's nature and the factors of the natural and social environment. Differing from those writers on social psychology and the social sciences who make some subjective factor, instinct or impulse, or even intelligence, as the central point of reference, and, differing from those who stress exclusively the forces of an environment as determinants of conduct, Professor Dewey takes a middle course and holds that there are forces *in* man as well as *wthout* him,. "Mind," he holds, "can be understood in the concrete only as a system of beliefs, desires and purposes which are formed n the interaction of biological aptitudes with a social environment," Yet throughout the author contends that the primary facts of social psychology center about habit or custom, and by so doing he gives to the subjective factors a position of relative frailty as compared with the exterior forces of the environment,. "Impulses, although first in time, are never primary in fact; they are secondary and dependent," simply because they are aroused and given meaning, moulded and developed by a relatively fixed medium. Impulses, however, are important as "organs or reorganization and readjustment" when habits fail to meet the demands of life; they are pivots "for giving new direction to old habits and changing their quality." The instincts of man being plastic and malleable, as witnessed by the wide diversity of social institutions and moral codes built upon them, the wise student of social reform will "need to find out just how different customs shape the desires, beliefs, purposes of those who are affected by them." This is the crucial problem of social psychology. ....

Professor Dewey has here employed his broad knowledge and ripened judgment to a critical examination of the foundation facts of all the social sciences. Though not everyone will be able to agree with his findings, centainly no student of social psychology and social philosophy concerned to get at the facts can fail to profit from a careful reading of this original and penetrating analysis of human behavior.

Ohio University Walter S. Gamertsfelder

Books and pamphlets for review should be sent to James P. Porter, Department of Psychology, Ohio University, Athens, Ohio, or William F. Book, Indiana University, Bloomington, Indiana.

BARKER, ELSA. *Fielding Sargent.* E. P. Dutton & Company, 681 Fifth Avenue, New York. 319 pp.

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* Mention here does not preclude further comment.

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